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DESIGNATED/ELECTED OFFICE (DO/EO/US)
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U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

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INTERNATIONAL APPLICATION NO
PCT/EP00/06465INTERNATIONAL FILING DATE
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TITLE OF INVENTION

FUNCTIONAL ELEMENT, METHOD FOR FIXING IT IN A SHEET METAL PART, ASSEMBLING ELEMENT
AND SWAGING ASSEMBLY

APPLICANT(S) FOR DO/EO/US

BABEJ, JIRI

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired
 - d. ☐ have not been made and will not be made.
8. ☒ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☒ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4)
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

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|----------------------------------------------------------------|--|--------------------------------------------------------|--|----------------------------------------------|--|
| U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 10/030410 | | INTERNATIONAL APPLICATION NO. PCT/EP00/06465 | | ATTORNEY'S DOCKET NUMBER 60174-026 | |
|----------------------------------------------------------------|--|--------------------------------------------------------|--|----------------------------------------------|--|

24. The following fees are submitted:

| BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) : | | CALCULATIONS PTO USE ONLY | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------|---------------------------|
| <input checked="" type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO | \$1040.00 | | |
| <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO | \$890.00 | | |
| <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO | \$740.00 | | |
| <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) | \$710.00 | | |
| <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) | \$100.00 | | |
| ENTER APPROPRIATE BASIC FEE AMOUNT = | | \$1,040.00 | |
| Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)). | | \$0.00 | |
| CLAIMS | NUMBER FILED | NUMBER EXTRA | RATE |
| Total claims | 23 - 20 = | 3 | x \$18.00 |
| Independent claims | 4 - 3 = | 1 | x \$84.00 |
| Multiple Dependent Claims (check if applicable). <input type="checkbox"/> | | | \$0.00 |
| TOTAL OF ABOVE CALCULATIONS = | | | \$1,178.00 |
| <input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2. | | | \$0.00 |
| SUBTOTAL = | | | \$1,178.00 |
| Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). | | | \$0.00 |
| TOTAL NATIONAL FEE = | | | \$1,178.00 |
| Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/> | | | \$0.00 |
| TOTAL FEES ENCLOSED = | | | \$1,178.00 |
| | | | Amount to be: refunded \$ |
| | | | charged \$ |

a. ☒ A check in the amount of **\$1,178.00** to cover the above fees is enclosed


b. ☒ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **08-2789** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO.

| | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Raymond E. Scott HOWARD AND HOWARD ATTORNEYS, P.C. 39400 Woodward Avenue, Suite 101 Bloomfield Hills, Michigan 48304 Telephone: (248) 645-1483 Facsimile: (248) 645-1568</p> | <p style="text-align: center;"> SIGNATURE</p> <p>Raymond E. Scott NAME</p> <p>22,981 REGISTRATION NUMBER</p> <p>January 3, 2002 DATE</p> |
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18/pv

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P 3788

A functional element, a method of inserting the functional element into a sheet metal part, a component assembly and a plunger arrangement

5 The present invention relates to a functional element comprising a shaft part and a head part designed for a riveted joint to a panel member, in particular to a sheet metal part, and a method of inserting the functional element into a sheet metal part and a component assembly comprising the functional element and the sheet metal part.

10

A functional element of the kind first mentioned is known, for example, from German patent 34 47 006 and is realised there as a threaded stud, with the head part being provided with a tubular piercing and riveting section which is designed to pierce a sheet metal part and to subsequently
15 form a rivet flange, whereby the element is fastened in the sheet metal part. The head part has a flange between the tubular piercing and riveting section with an annular surface which is perpendicular to the longitudinal axis of the element and which is normally arranged just below the side of a sheet metal part adjacent to the shaft part after the insertion of the
20 element into a sheet metal part.

The panel slug formed in the piercing of the sheet metal part is pressed into the piercing and riveting section and thus supports the riveted joint to the sheet metal part. DE PS 34 47 006, however, also describes functional
25 elements in the form of nut elements, where the shaft part is to be understood as an extension of the head part and this is provided with a female thread. However, the shaft part does not have to be realised as a thread; many embodiments are possible, for example a guide spigot or a pin-like

design to which, for example, carpets can be fasted by means of corresponding clips.

Such functional elements, i.e. in accordance with DE PS 34 47 006 C2,
5 have proved themselves over many years and allow the production of a high-quality joint between the element and the sheet metal part. Such elements are, however, relatively costly in production and sometimes require the use of extremely precisely operating cold forming machines which work relatively slowly to obtain the desired quality. The need to use
10 relatively expensive cold forming machines and the limited operating speed lead to relatively high production costs. Furthermore, it would be more favourable for some applications if the weight of the elements could be reduced.

15 It is the object of the present invention to provide functional elements which can be manufactured very economically and at a favourable cost, which preferably have a lower weight than comparable elements of the initially named kind and which also have an acceptable resistance to pull-out or twist-out for many purposes.

20

In accordance with a first embodiment for the satisfying of this object, provision is made in accordance with the invention that at least the head part of the element is made hollow and has at least substantially the same outer diameter as the shaft part. The element therefore has no flange
25 between the head part and the shaft part. It is furthermore possible in accordance with a second version of the invention to make the head part with a larger or smaller diameter than that of the shaft part, with a transition taking place with a change in the diameter between the head part and

the shaft part, but with no flange part in the conventional sense being present.

The function of the flange part in the known elements is, on the one hand,
5 to provide a sufficient area which prevents the element from becoming
loose in the sheet metal part and, on the other hand, also to form a sur-
face on which further sheet metal parts or other components can be fas-
tened, for example, if the element in question is a bolt element, by a nut
which is screwed onto the shaft part of the functional element having a
10 thread.

In the functional elements in accordance with the invention, this flange is
initially not present on the actual functional element. When the functional
element is inserted into the sheet metal part, the end of the functional
15 elements pierces the sheet metal part, as with the elements known per se,
and formed into a rivet flange on the side of the sheet metal part remote
from the shaft part of the element. Subsequently, the functional element is
compressed in the longitudinal direction such that a part of the hollow
head part is formed into an annular fold or annular bulge which now
20 serves as a flange and assumes the functions of the conventional flange
described above.

Particularly preferred embodiments of the functional element can be found
in claims 2 to 11.

25

As the head part in the functional element has at least substantially the
same outer diameter as the shaft part, the demands on manufacturing it
as a cold formed part are substantially lower than with the manufacture of

a head part with a flange whose diameter is substantially larger than that of the shaft part. Thus, lower priced cold forming machines with a faster operation can be used, whereby the production costs can be cut.

5 Furthermore, the functional element cannot only be manufactured in an economic manner by cold forming, but also by high-pressure forming methods from lengths of tubing. Moreover, a variety of other, lower priced manufacturing procedures are possible. Although only a hollow head part is necessary for the attachment of the part to a workpiece, the functional
10 element can easily be manufactured overall as a tubular part. A manufacture with a larger inside diameter in the hollow head part than in the shaft part can also be realised at favourable cost, particularly when a tube is used as the starting material.

15 As indicated above, in the present invention, the actual flange is only formed at a later point. As the sheet metal part is clamped in a form-locked manner within a relatively large-area mount between the rivet flange on the one hand and the annular fold on the other, the functional element in accordance with the invention has a good resistance to twist-
20 ing. The embodiment in which the panel slug is clamped inside the rivet flange increases the security against rotation even further and also increases the resistance to being pulled out.

Should it be necessary to increase the security against rotation even
25 further, this can be done in a number of different ways. On the one hand, smaller features providing security against rotation, such as grooves or noses, can be provided in the region of the head part forming the rivet flange; on the other hand, radially extending noses can be provided either

in the die to form the rivet flange and/or in the end face of the plunger forming the annular fold which then also lead to a joint deformation of the sheet metal part and the adjoining regions of the rivet flange and/or the annular fold which serve to increase the security against rotation. It is also possible to equip the surface of the annular fold with sharp, radially extending noses or the like which provide an electrical contact to a connecting terminal. Such noses can be provided either on the outer surface of the head part before the insertion of the element or formed or embossed in the exposed surface of the annular fold only subsequently when the annular fold is formed.

Particular advantages and preferred embodiments of the functional element and of the method of inserting the element into a sheet metal part, of the component assembly made in this way, of the die used to manufacture the component assembly and of the plunger arrangement used can be seen from the claims and the following description.

The invention is described in more detail below by way of embodiments and with reference to the enclosed drawing in which are shown:

20

Fig. 1 a view, partially cut away in the longitudinal direction, of a functional element in the form of a bolt element;

Fig. 2 the first step in the insertion of the functional element into a sheet metal part;

25

Fig. 3 an intermediate stage in the insertion of the functional element into a sheet metal part;

- Fig. 4 the end of the insertion method prior to the opening of the press or caliper used therefor;
- 5 Fig. 5 a partially cut-away view of the finished component assembly, i.e. the result after the end of the method step in accordance with Fig. 4;
- Fig. 6 a representation of a functional element with a head part having a greater diameter than that of the shaft part;
- 10 Fig. 7 the element of Fig. 6 in the assembled state;
- Fig. 8 a representation similar to Fig. 6, but where the head part has a smaller outer diameter than the shaft part;
- 15 Fig. 9 the functional element of Fig. 8 in the assembled state;
- Fig. 10 a representation similar to Fig. 1, but at a larger scale and of a hollow element;
- 20 Fig. 11 a view, partially cut away in the longitudinal direction, of a further functional element in accordance with the invention in the form of a nut element;
- 25 Fig. 12 the nut element of Fig. 11 in the assembled state;

- Fig. 13 a functional element partially cut away in the longitudinal direction which is made as a pin to receive a spring clip;
- 5 Fig. 14 shows in Figs. 14B, 14C and 14D a modified setting head designed for the insertion of the tubular element in accordance with Fig. 14A into a sheet metal part in such a way that no damage to the thread cylinder need be feared, with Fig. 14E showing the completed component assembly;
- 10 Fig. 15 shows a further embodiment of an element in accordance with the invention similar to that of Fig. 1, also in a representation partially cut away in the axial direction, with this element being used in the following description of the die and process technology preferred in accordance with the invention in accordance with Figs. 16 to 18;
- 15 Fig. 16A an axial section through a die in accordance with the invention;
- 20 Fig. 16B an end view of the die of Fig. 16A seen in the direction of arrow B;
- 25 Fig. 17 a sequence of drawings in which Figs. 17A to 17H show the method preferred in accordance with the invention of attaching the functional element in accordance with the invention and using the die preferred in accordance with the invention, with Fig. 17I illustrating the completed component assembly in a partially cut-away form;

Fig. 18 A to

Fig. 18C a preferred embodiment of the plunger arrangement in accordance with the invention which is preferably used in the method in accordance with Fig. 17;

Fig. 19 a partially cut-away view to illustrate the attachment of an element in accordance with the invention to a sandwich-like component, the element and the component being shown prior to the attachment of the element on the left side of the central longitudinal axis and after the attachment of the element on the right side of the central longitudinal axis; and

Fig. 20 a schematic representation similar to that of Fig. 19, but with a modified kind of sheet metal preparation.

The functional element 10 of Fig. 1 comprises a shaft part 14 provided with a male thread 12 and a hollow head part 16 having at least substantially the same outer diameter as the thread cylinder of the shaft part 14.

A circularly cylindrical hollow space 18, which is located within the hollow head part 16, leads from the end 20 of the head part 16 remote from the shaft part 14 up to directly below the thread cylinder and ends there in a transverse wall 22. The hollow space 18 here has the form of a bore. The shape of the transverse wall 22 corresponds to the base of a bore made with a twist drill, although the hollow space 18 and the transverse wall 22 do not necessarily have to be made with a twist drill, even though this does represent one possibility. The hollow space and the transverse wall could, for example, be made by means of a cold forming process. The

longitudinal axis of the functional element 10, which is realised here as a bolt element, is designated with 24.

The element 10 is made at the end 20 exactly like the corresponding end
5 of the piercing and riveting section of the functional element in accordance with DE PS 34 47 006 C2, i.e. it has an inner cutting face 26 and an outer, rounded off punching and drawing edge 28.

In Fig. 1, the cutting face 26 is made very small. As a rule, it is, however,
10 made in accordance with the conical cutting face 426 of the embodiment in accordance with Fig. 11.

Figs. 2, 3 and 4 now show three different stages in the insertion of the functional element 10 in accordance with Fig. 1 into a sheet metal part 30.
15 The insertion method is described in more detail below with reference to the further Figures 15-18, which represent the currently preferred embodiment in detail. The present description is intended as an introduction for a knowledgeable reader.

20 As is shown in Fig. 2, the sheet metal part 30 is supported at the bottom on a die 32 which is equipped with a centrally disposed cylindrical plunger projection 34 which is designed in accordance with the plunger projection of the corresponding die in accordance with DE PS 34 47 006 C2. This plunger projection is surrounded by a rounded annular depression 36
25 which merges into an annular recess 40 of a larger diameter at the end face 38 of the die remote from the sheet metal part 30. The die 32 is overall very similar to the die 180 described in DE PS 34 47 006.

The die 32 is located in a lower tool of a press (not shown). The sheet metal part is clamped against the end face 38 of the die by a, for example, tubular hold down member, which is not shown, but which is arranged concentrically to the cylindrical outer plunger 42 of the setting head 44.

5 That is, the sheet metal part 30 is clamped tight outside the annular recess 40. The shaft part of the functional element 10 is located in the cylindrical guide passage 46 of the setting head 44, while the head part 16 projects out of the cylindrical outer plunger 42. An inner plunger 48, which presses onto the end 29 of the shaft part 12, is arranged within and

10 concentric to the tubular outer plunger 42. Although the inner plunger 48 can be drawn back with respect to the outer plunger for the insertion of the respective functional elements, the relative position of the inner and outer plungers 48, 42 remains constant for the process steps in accordance with Figs. 2, 3 and 4. The same applies to the apparatus to be

15 described below.

In the stage of the process step in accordance with Fig. 2, the end face 20 of the functional element has pressed the sheet metal part into the annular recess 40 of the die 32 under the pressure of the inner plunger 48 and

20 drawn a shallow, approximately conical recess in the sheet metal part 30. In the stage of Fig. 2, the plunger projection 34 in cooperation with the cutting surface 26 at the end of the head part 16 of the functional element 10 has cut out a panel slug 50 from the sheet metal part.

25 It can be seen from Fig. 3 that the plunger arrangement 43 comprising the inner plunger 48 and the outer plunger 42 has travelled further downwards, with the free end region of the hollow head part of the element 10 being formed into an annular rivet flange 37 around the downwardly

drawn rim of the aperture of the sheet metal part as a result of the rounded annular depression or roll surface 36 in the die. The hole in the sheet metal part has a marginal region in this stage of the process which is similar to the mouth of a trumpet.

5

In the continued course of the joint downward movement of the inner plunger 48 and the outer plunger 42, the cylindrical wall of the head part 16 is compressed in the region directly beneath the shaft part 14 such that an annular fold 52 is formed, as can be seen from Fig. 4. The constraints to which the element is subjected due to the guiding by the outer plunger 42 on the one hand and due to the punched edge and the panel slug on the other ensure that the deformation takes place as shown in Fig. 4.

15 It can be seen from Figs. 2 and 3 that the outer plunger 42 has an annular nose 56 at its end 54 with a face extending perpendicular to the longitudinal axis 24 of the functional element. This annular nose 56, which is not absolutely necessary, presses on the annular fold in the method stage in accordance with Fig. 4 and ensures that a clear fold is made here so
20 that the material of the wall of the head part is folded like a hair grip, i.e. through 180°, and the two layers of material formed in this way fully contact one another. Furthermore, the annular nose ensures that the annular surface 57 of the ring fold formed in this way lies slightly below the plane of the sheet metal part 30. The ring flange 52 formed in this way
25 now has the function of a flange which was already present in the starting stage in the elements previously known. It is also ensured by the annular nose 56 that the material package is compressed in an axial direction in the region of the form-locked joint of the hollow head part 16 of the func-

The further Figs. 6 to 13 now show different possible aspects of the functional element in accordance with the invention and are described in more detail below. In all following examples, the same reference numerals are used as for the embodiment of Figs. 1 to 5, but increased for each embodiment successively by the base number 100 for clear identification. It is, however, understood that features characterised by the same two last numerals always have the same or a corresponding function as in the embodiment in accordance with Figs. 1 to 5. Such features are only described separately if a different aspect has a special importance.

Fig. 7 now shows the functional element 110 of Fig. 6 in the assembled state. It can be seen clearly here that the annular fold 152 forms a flange
25 as in the embodiment in accordance with Fig. 5.

In the embodiment of Fig. 8, the head part 216 has a smaller outer diameter than the outer diameter of the thread cylinder of the shaft part 214 of

In the state fitted into a sheet metal part, the form-locked joint of the head
 25 part 316 to the sheet metal part corresponds to the previous embodiment
 in accordance with Fig. 5.

Fig. 11 shows a further embodiment version similar to the embodiment of Fig. 10, but in this case the element is provided with a female thread 412.

Fig. 12 shows the assembled state of the functional element in accordance with Fig. 11. It can be seen that the hollow head part 416 is deformed in exactly the same way as in the prior embodiments – with the difference that in this case the upper annular surface 457 of the annular fold 452 is arranged a little above the sheet metal part. However, this is not absolutely necessary. The corresponding surface could equally well be arranged beneath the plane of the sheet metal part 430 or at the same height as the plane of the sheet metal part.

It can also be seen in Fig. 12 that the panel slug 450 closes the central passage of the hollow functional element 410 in the region of the rivet flange 437 so that a sealing is performed at this point. The panel slug can, however, also be removed.

The embodiment in accordance with Fig. 12 then has the particular advantage that a bolt element (not shown) can be screwed into the functional element 410 from below. In this way, the annular fold and the rivet flange and the material of the sheet metal part 430 clamped therebetween are drawn even tighter together when the bolt is tightened, with the large contact surface 480 of the annular fold forming a very stable connection. In the event that the functional element 410 is to be used with such a bolt, the panel slug 450 is pressed into and removed from a central passage of the die, for example, by means of a leading piercing plunger. The removal of such a panel slug in this manner is already known. The leading piercing plunger is used to pre-pierce the sheet metal part in such cases.

Fig. 13 shows a functional element 510 which is also made in tubular form, but which has no thread. The functional element instead has a peripheral groove 560 which is intended to receive a spring clip (not shown). It can also be seen that the free end 529 of the functional element 510 of Fig. 13 is made in a conical shape. The corresponding spring clip can be pressed downwards over this conical surface and then springs into the groove 560.

25 In the embodiments with a hollow shaft part, the inner plunger 48 can optionally be guided into the hollow internal space of the shaft part to stabilise the functional element during the compression procedure. This

procedure, which also has an advantageous effect on the formation of the annular fold, is shown in Fig. 14 in the drawings 14B, 14C and 14D. For this purpose, the inner plunger 648 has a journal-like projection 649 with a diameter corresponding to the inner diameter 651 of the hollow shaft part 614, with the projection 649 merging into the upper part of the inner plunger via an annular shoulder 653 which presses onto the annular end 629 of the shaft part.

The outer plunger 642 of the plunger arrangement 643 in accordance with Figs. 14B to 14D can be provided with a circular cylindrical bore whose diameter corresponds to the diameter of the external thread 612 of the shaft part 614, approximately as shown in Figs. 14C and 14D.

Despite the spigot-like projection 649 of the inner plunger 648, with such an arrangement it is, however, possible under certain circumstances that the thread cylinder is damaged and/or that the thread cylinder is compressed. The double arrows of Fig. 14B indicate a possible remedy. This remedy consists of the outer plunger 642 being divided into at least two segments which, corresponding to the double arrows 655, can be moved radially away from the element 610 into position 657 in which they do not impair the insertion of the element 610 through the plunger passage 646 of the setting head. These segments, of which there may be two, three or more and which then have a corresponding angular extent (for example 180°, 120°, etc.), can be provided on their radially inner sides with a shape 659 matching the thread cylinder 612 so that, during a closing movement of the segments of the outer plunger in a direction radially towards the longitudinal axis 624, the thread segments of the corresponding thread 659 engage the thread of the thread cylinder 612 and in this way serve to

transmit axial forces to the element 610 on the one hand and, on the other hand, prevent any compression of or injury to the thread cylinder 612 from occurring. For this purpose, the design of the thread segments 659 is selected complementary to that of the thread cylinder 612.

5

After the attachment of the element in accordance with Fig. 14D, the segments of the outer plunger 642 are then moved apart again, that is in a direction radially outwardly away from the longitudinal axis 624, so that the outer plunger 642 can travel upwards for the removal of the completed component assembly in accordance with Fig. 14E without the thread cylinder being damaged thereby.

10

The concept of the radial movement of segments of the outer plunger 642 will be described in more detail below with reference to a preferred embodiment in accordance with Fig. 18.

15

Fig. 15 now shows a functional element 710 which is very similar to the functional element 10 of Fig. 1 and which basically only differs from this in that the base of the hollow space 718, which forms the transverse wall 722, is made only slightly concave here instead of conical and extends substantially perpendicularly to the longitudinal axis 724 of the element 710 and merges into the cylindrical outer wall of the head part 716 of the element 710 via a generous radius 723. While this shape of the base forming the transverse wall 722 is not absolutely necessary, it does lead to a more high quality support of the shaft part in a practical example, which serves the stability of the connection.

20

25

This embodiment has the advantage that while the functional element is still made with a conical cutting surface 726, the face 720 of the head part 716 is made simply as an annular surface which is perpendicular to the longitudinal axis 724 and which is not rounded as, for example, at the rounded portion 28 in Fig. 1. A manufacturing step is saved in this way in the manufacturing of the functional element. The annular recess 740 of the die 732 is in principle of similar design to the annular recess 40 of the die 32 in accordance with Fig. 2, but is rounded convexly at the transition into the end face 733, as shown at 737. Furthermore, a plurality of inclined grooves 739 – in this embodiment eight such grooves, as shown in Fig. 16B – are worked into this rounded transition 737 so that radially extending noses 741 are in each case formed between two adjacent grooves 739.

The grooves 739 are at least substantially semi-circular in shape in cross-section and well rounded, like the noses 741 therebetween, so that while they do deform the sheet metal part, they do not injure it. These grooves 739 and noses 741 serve to increase the security against rotation of the element with respect to the sheet metal part.

Figs. 17A to 17H now show the die 732 in accordance with Fig. 16, which is used to attach the functional element 710 to a sheet metal part 730 using a plunger arrangement 743.

5 The die 732 is here located in a bore 760 of a lower tool 762 of a press whose upper side 764 is arranged flush with the face 733 of the die. A plurality of tappets 768 upwardly biased by spring 766 are located in the lower tool 762 and support the sheet metal part 730 during the insertion into the press, but can be pressed downwardly due to the force exerted by
10 the hold down member 770 when the press is closed so that the sheet metal part 730 comes into contact with the end face 733 of the die 732 and with the upper side 764 of the lower tool in the region of the die and is immovably clamped there between the hold down member 770 and the die 732 or the lower tool 762.

15 Three such spring-biased tappets 768, for example, can be provided which are arranged, for example, at equal angular intervals around the central longitudinal axis of the die 732, with only one tappet 768 being visible due to the sectional drawing. The central longitudinal axis of the die is simultaneously the central longitudinal axis 724 of the functional element 710,
20 that is it is aligned therewith.

The hold down member 770 is also biased in the direction of the sheet metal part by springs 772 which here – like the spring 776 – are indicated
25 schematically as compression coil springs, although other spring types can also be used which are well known in tool-making. The hold down member 770 can belong to a setting head having the plunger arrangement 743 or to a tool of the press on which the setting head is fitted. The upper

ends of the springs 772 are accordingly braced against the setting head or the tool.

In this example, three springs 772 are also arranged at equal angular intervals around the central longitudinal axis 724 so that the hold down member 770 is pressed evenly downwards under the force of these springs.

Fig. 17A shows the state after the sheet metal part 730 has been inserted into the press and the closing movement of the press has been begun – just so far that the hold down member 770 contacts the upper side of the sheet metal part and lightly clamps the sheet metal part between it and the tappet 768.

The plunger arrangement 743 here also comprises an outer plunger 742 and an inner plunger 748, with the lower end 774 of the inner plunger 748 pressing onto the upper face 729 of the functional element 710. It can be seen that the head part 716 of the functional element 710 projects at least substantially completely from the outer plunger 742, with the transverse wall 722 forming the base being arranged only slightly above the lower face 776 of the outer plunger 742. The shaft part 714 of the functional element 712 is, in contrast, located completely inside the outer plunger 742.

It can be assumed in this representation that the lower tool 762 represents the lower tool of a press while the setting head is fixed in the upper tool of the press or on an intermediate plate. Different arrangements are also feasible which were described at the end of the description of Fig. 5.

As the press continues to close, the spring-biased hold down member 770 is pressed so hard against the sheet metal part 730 that this presses the spring-biased tappets 768 downwards until the sheet metal part 730 is now clamped firmly and immovably between the hold down member 770 and the lower tool 762 or the face 733 of the die. In this example, a further downward movement of the hold down member 770 is not planned. The upper tool of the press or the intermediate plate of the press can, however, be moved further downwards in accordance with the further closing movement of the press, whereby the compression coil springs 772 are further compressed, without the hold down member 770 changing its position.

In this further closing movement of the press, the outer plunger 742 is also pressed so far down together with the inner plunger 748 in the stage of Fig. 17B that the lower end 720 of the functional element 710 has just cut a panel slug 750 out of the sheet metal part 730 in cooperation with the plunger projection 734 of the die 732.

It can be seen that the inner diameter of the shaft part 716, that is the diameter of the hollow space 18, is only slightly larger than the outer diameter of the plunger projection 734. It can further be seen that the lower end 720 of the functional element 710 has pressed the marginal region 778 of the aperture of the sheet metal part 730 created by the separation of the panel slug 750 into the annular depression 732 of the die under the pressure of the plunger 748 so that this marginal region 778 forms a conical recess in the sheet metal part 730.

In the further closing movement of the press in accordance with Fig. 17C, the marginal region 778 of the aperture created by the removal of the panel slug 750 is pressed even further into the annular depression 736, with the end 720 of the functional element 710 having just reached the U-
 5 shaped base region of the annular depression 736 and just being about to be deformed radially outwardly by the shape of this base region.

This deformation is then continued during the further closing of the press in accordance with Fig. 17D so that the end 720 is now rolled annularly
 10 outwards and engages round the lower end of the marginal region 778, whereby the rivet flange is now being created. During this further closing movement of the press, the panel slug 750 is always pushed further axially into the shaft part 716 of the functional element 710. As the press continues its closing movement, in the state of Fig. 17E, the cylindrical
 15 wall of the shaft part 716 now begins to be expanded radially outwards in the region inside and above the marginal region 778 of the sheet metal part 730 and beneath the transition to the shaft part 14, so that the wall of the head part in the region of the face 735 of the plunger projection 734 begins to move away therefrom in a radial direction. The panel slug 750 is
 20 displaced further in the direction towards the shaft part 14 of the functional element 710.

As the press continues the closing movement, the state in accordance with Fig. 17F is reached, where it can be seen that a clear kink 728 has arisen
 25 in the wall of the head part 716 of the functional element 710 directly adjacent to the plunger projection 756.

As the closing movement of the press continues further, the region of the wall of the head part 16 of the functional element 10 below the kink position 782 is now formed into an annular fold or to an annular bulge 752. The face 754 of the outer plunger 742 now presses onto the top of the sheet metal part 730. The plunger projection 756 has now pressed the top of the ring fold 752 flat so that its surface is arranged slightly beneath the plane of the top of the sheet metal part 730 and is additionally perpendicular to the longitudinal axis 724. The panel slug 750 has now directly reached the end of the hollow space 718 of the head part 16 of the functional element 10 and supports the ring fold 752 from the inside. The press is now completely closed in the state of the drawing in accordance with Fig. 17G. The insertion of the functional element 710 into the sheet metal part 730 is now complete.

The sheet metal material and the material of the head part 16 of the functional element 10 is now deformed in the region of the grooves 739 and noses 741 of the die 732 by the pinching of the annular fold by the plunger projection 756 so that the sheet metal material hooks up with the material of the functional element here, whereby a high-quality security against rotation is created.

The press now starts to open, as shown in Fig. 17H. The tappets 768 press the sheet metal part with the attached functional element away from the lower tool 762 and lift the sheet metal part with the attached functional element out of the die 732. The further opening movement of the press then leads to the shaft part 714 of the functional element 710 being removed from the plunger 742. The sheet metal part with the functional

element attached thereto can now be removed from the press and appears as shown in the representation in accordance with Fig. 17I.

It can be seen that the inner plunger 748 and the outer plunger 742 move
 5 in synchronism with one another during the total closing movement of the
 press from the state of Fig. 17A to Fig. 17G and even also including Fig.
 17H. This can be achieved, for example, by the inner plunger 748 having a
 head part of a larger diameter above the outer plunger 742, this head part
 coming into contact with the outer plunger 742 so that a relative move-
 10 ment of these two parts is prevented from this point on. The inner plunger
 748 should, however, still be capable of upward movement relative to the
 outer plunger 742 to allow the insertion of the functional element 710 into
 the plunger passage of the inner plunger 742.

15 Fig. 18 shows a possible plunger arrangement 842 in detail which can be
 used advantageously instead of the plunger arrangement 743 in accor-
 dance with Fig. 17.

The outer plunger 842 is provided with an inner bore 886 which is ar-
 20 ranged coaxially to the longitudinal axis 824' and displaceably receives the
 inner plunger 848. A supply passage 888 is shown on the right-hand side
 of the sectional drawing in accordance with Fig. 18A through which the
 functional elements 810 can be inserted from a feed device (not shown)
 into the plunger passage formed by the bore 886. Although the functional
 25 elements 810 shown in Fig. 18A approximately have the shape of the
 functional elements 10 in accordance with Fig. 1, where the base of the
 transverse wall has a conical design, basically all functional elements
 described up to now can be used, above all the functional elements 710 in

When the press is opened, the outer plunger 842 is displaced downwards with respect to the inner plunger 848, usually under the pressure of a corresponding spring until the end face 874 of the inner plunger 848, approximately reaches the level of the upper boundary of the supply passage 888 so that a functional element 810 can be inserted into the plunger passage 886 by pressure in the direction of the arrow 890.

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In this embodiment, three segments 904, which are arranged at equal angular intervals around the central longitudinal axis 824', are located in the region between the upper part 894 and the lower part 892 of the

plunger arrangement 842. The three segments 904, of which only two can be seen in Fig. 6, together form a receiver 905 arranged coaxially to the longitudinal axis 824' for a respective functional element 810. The lower surfaces 908 of the segments 904 pointing radially inwards are made as a segment of a thread cylinder which is designed to be complementary to the thread cylinder 812 of the shaft part 814 of the functional elements 810. The upper surfaces 912 of the segments 904 pointing radially inwards together form a passage 913 having a diameter which is somewhat smaller than the outer diameter of the head part 816 of the respective functional elements 810. The radially outer surfaces 914 of the segments 904 are designed as partially conical surfaces which are complementary to the conical surface 900 of the corresponding recess of the upper part 894 of the outer plunger 842. The radially upper surfaces 916 of the segments 904 are designed complementary to the annular shoulder 902 so that in the position of Fig. 18A, the partially conical surfaces 914 of the segments 904 and the partially circular surfaces 916 fully contact the respective opposing surfaces of the outer plunger 843, i.e. the surface of the conical recess 900 and the annular shoulder 902.

In this position, the through passage 913 formed by the segments 904 is made such that it is smaller in diameter than the outer diameter of the head part 16 of the functional element 810. In this way, the respective functional element 810 can initially not fall between the segments, but is rather supported at the upper end of the segments 904 as is shown in Fig. 18A.

The upper region of the respective segments 904 merges into a partially cylindrical wall part 922 via a partially conical surface 920. The partially

conical surfaces 920 of the segments 904 are opposite the conical surface 898 of the lower part 892 of the plunger arrangement 842 in the position in accordance with Fig. 18A and are spaced therefrom. The partially cylindrical surfaces 922 of the segments 904 are opposite the partially cylindrical surface 896 of the lower part of the plunger arrangement 843 and are radially spaced therefrom in each case.

To ensure that the segments 904 always return to the starting position of Fig. 18A, tappets 928 biased by springs 926 are provided whose axes 930 are inclined with respect to the longitudinal axis 824' of the plunger arrangement 843 and perpendicular to the conical surface 898 of the lower part 892 of the plunger arrangement 843. The spring bias causes the tappets 928 to be pressed against the partially conical surfaces 922 of the segments 904 contacting them directly such that when the press is open, these always assume the position shown in Fig. 18A. The spring bias is not very strong.

If the press is now closed, the inner plunger 848 is pressed downwards with respect to the outer plunger and in this process presses the respective functional element 810 located in the plunger passage 886 against the upper face of the segments 904. As a result of the sloped entrance to the passage 913 and the correspondingly inclined outer surface in the region of the lower face 820 of the respective functional element 810, the force exerted on the inner plunger 848 is sufficient to press the segments radially downwards in the axial direction 824' and radially outwards so that they press the pins 928 downwards until the partially conical surfaces 920 come into contact with the conical surface 898 of the lower part 892 of the outer plunger 843.

Although not shown in Figure 18, the arrangement is made such that the inner plunger 848 cannot move any further downwards than as shown in Fig. 18C. This can, for example, be prevented by the upper part of the inner plunger 848 being provided with a head which has come into contact with the outer part 842 of the plunger in its "lowest" position in accordance with Fig. 18C. The whole force of the press is now transferred via

Although not shown in Figure 18, the arrangement is made such that the inner plunger 848 cannot move any further downwards than as shown in Fig. 18C. This can, for example, be prevented by the upper part of the inner plunger 848 being provided with a head which has come into contact with the outer part 842 of the plunger in its "lowest" position in accordance with Fig. 18C. The whole force of the press is now transferred via

the inner plunger 848 to the face 829 of the functional element 810 and via the outer plunger 842 and the segments 904 to the thread 812 of the functional element. It is ensured in this way that the thread cannot be damaged as it is received in a form-locked manner inside the complementary thread parts of segments 904 so that the thread cylinder cannot be compressed. If the shaft part 814 of the functional element is intended to be made hollow, the cylindrical projection 930 of the inner plunger 848 can be designed accordingly and can extend via an annular shoulder (not shown) pressing onto the end 829 of the functional element 810 into the inner bore of the shaft part so that the pressing forces can be transmitted to the functional element 810 without any damage to this element by the pressing together of the walls of the hollow shaft part needing to be feared, as this element is supported by the extended projection of the inner plunger.

It should be pointed out at this point that the number of segments 904 is not limited to three. The minimum number required to realise this embodiment is two; however, three, four or more such members can also be used, with preferably one respective pin 928 with bias spring 926 being provided for each member.

The lower ends of the segments 904 can, if required, be provided with noses 956 which jointly form the plunger projection 756 of Fig. 17.

After the attachment of the functional element 810 in accordance with the drawing sequence of Fig. 17, the press opens again, whereupon the sprung hold down member exerts a force on the sheet metal part with the attached functional element, with said force being sufficient to draw the

segments 904 downwards into the position of Fig. 18B in order to release the shaft part 814. As the spring tension of the spring 928 is small, the release of the functional element when the press is opened is carried out without damaging the respective functional element 810 just attached.

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After the release of the functional element 810 just attached, the opening of the press results in the outer plunger 842, which is biased downwards by the spring force, being pressed downwards, while the inner plunger 848 is drawn upwards until it reaches the starting position where the lower
10 end face of the inner plunger 848 has reached the level of the upper boundary of the passage 888, whereby a new element is introduced into the plunger passage 886 by the pressure in the direction of the arrow 890. The working cycle then begins afresh with a new sheet metal part and with a new functional element 810, namely the functional element that is
15 now located in the plunger passage 886.

The tool arrangement can be a station in progressive tooling where a strip of sheet metal is led through a plurality of stations to carry out a plurality of operations. The tool arrangement can, however, also be used in a pierc-
20 ing press which only performs a single working step for every stroke. The attachment of the tool arrangement to a robot or another kind of tool is also possible.

The functional elements in accordance with the present invention are not
25 only intended for use with purely metal sheet parts, but can also be used with a number of further components which can be understood as composite components.

Such components are frequently brittle or elastic components which consist of a material containing hollow spaces or pores and frequently of a material. The following materials can be given as examples of materials used for the manufacture of components, in particular of brittle or compliant components, which can be fitted with functional elements in accordance with the invention:

Metal foams

These are highly porous metal materials whose pore size and distribution can be set to a defined value in the manufacturing process and which are interesting for a wide range of possible applications. Such metal foams also offer savings in material and weight, and thus also cost savings, for a variety of components. They can absorb impact energy through progressive deformation and can therefore, for example, be used for energy-absorbing parts such as structural parts of vehicles which are intended to absorb impact energy to protect the occupants in cases of accident. Furthermore, they have excellent damping properties so that they can easily absorb or attenuate sound waves and mechanical vibrations.

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Metal foams made, amongst other things, of aluminium or magnesium and metal foams made of steel are known. Different manufacturing processes are known which can be used for the production of such metal foams. For example, metal powder can be mixed with a chemical compound which later – in a thermal treatment – effects the foaming of the metal. Gas, which causes the foaming, is released at the metal's melting point. It has already been possible in this way to produce foamed aluminium with a gas portion of up to 97%. Steel foams can also be produced

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using this method. The process can be used for a wide range of elements and alloys. The possibility also exists of making metal structures from hollow balls, for example hollow steel balls.

5 For the production of magnesium foams with a gas portion of up to 60% it is known to embed thin-walled hollow ceramic balls in a magnesium matrix in a casting process, with magnesium alloys also being used and being freely selectable.

10 Such materials can be harder and more brittle or, however, softer and more ductile than the starting alloy, depending on the matrix alloy.

After their manufacture, the foams frequently exhibit a cast skin which is either removed or smoothed using a filler material. Foams with a cast
15 skin, which is optionally filled with a filler material, form a kind of sandwich structure.

Sandwich structures with metal foams

20 The metal foams described above can be produced with or without a cast skin and with upper and/or lower covering layers made of sheet metal or plastic to produce material composites in the form of a sandwich structure with a core made of a metal foam.

25 Properties such as scratch resistance, low or high friction, corrosion resistance and good wear properties can be achieved by the application of coatings or coating layers to the core. The corresponding components or any covering layers present can be coated using all known coating meth-

ods, i.e. using electroplated coatings, lacquer coatings or coatings applied, amongst other things, by means of PVD methods. When sheet metal layers are provided on a core consisting of foam, the sheet metal layers can be glued or bonded to the metal foam core, with soldering or brazing methods also being possible. Glues are normally used to achieve the bond to the core for covering layers made of plastic.

Another method to produce sandwich structures is to provide hollow sections made of metal or plastic, for example, in the form of sections extruded in an extrusion process, either completely or regionally with a metal foam core. This can be done by the insertion of elongate strips of foam metal, optionally with a surface bonding of the foam metal to the section, or by the foaming of metal/foam mixtures in the hollow section. Open sections or shaped sheet metal parts can also be provided with an insert made of foam metal (insert made of one layer of foam metal or of a plurality of layers of foam metal) and then covered with a covering strip or section which is fastened to the open section in the marginal region by welding, riveting, bonding or otherwise. Plastic foams or other materials in such composite structures can also be used instead of foam metal. A concrete use of such sections filled with foam metal or a plurality of fillers is the use as a B column of a motor vehicle which can be made by the filling of a pre-fabricated section, optionally with a subsequent shaping by bending or pressing.

The desired mechanical properties can be set by the section-wise filling of such sections. For example, the desired rigidity or buckling strength can be achieved in one region and the desired deformation, for example, in the event of an accident, in another.

Material composites consisting of a core with a honeycomb structure and of upper and/or lower covering layers can also be used, whereby the covering layers can be made of sheet metal or plastic plates. The honeycomb structure can be made of metal, metal foils or of cardboard or paper or of plastic or of cellulose or lingo-cellulose.

Such materials include castings made, for example, of magnesium, magnesium alloys and thermosetting plastics, with and without fillers. Such materials can also be used for components which are fitted with functional element arrangements in accordance with the invention.

Plastic components, components made of woods or pressed boards or the like can also be used for the component assemblies in accordance with the invention, with such materials usually having to be considered as compliant as they normally yield a lot under the forces which prevail in the making of a rivet joint.

25 Special material composites are also feasible which consist of a combina-
tion of one or more of the above materials, for example of multi-layer
arrangements comprising a plurality of layers bonded to one another,

whereby, for example, thicker components or components with more complex shapes can be built up.

Figures 19 and 20 show two possibilities of how a functional element 1010 in accordance with the invention can be used with a composite component 1030.

Fig. 19 shows the functional element 1010 in the starting state in a half-section on the left-hand side of the central longitudinal axis 1024, with the other half of the functional element 1010 being made symmetrically on the other side of the central longitudinal axis 1024 – with the exception of the thread, which naturally forms a continuous thread cylinder with the shown half of the thread.

In deviation from the prior embodiments, a flange 1011 is provided here between the shaft part 1014 and the head part 1016 and, as shown here, preferably bears noses 1013 which serve as additional security against rotation. The flange part 1011 with the features 1013 providing security against rotation can, if desired, be omitted; but it does provide a more stable attachment of the functional element 1010 to the composite component 1030 here. The composite component 1030 can have one of the embodiments given above for composite components.

Prior to the attachment of the functional element, the composite component is prepared as is shown on the left-hand side of the central longitudinal axis 1024.

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hollow head part 1016 of the functional element 1010, which is here identical to the corresponding element 1010 of Fig. 19.

In this embodiment, the lower end of the functional element 1010 is equipped with piercing features which cause the stamping out of a panel slug 1050 in cooperation with a corresponding die (approximately corresponding to the die of Fig. 2), with this panel slug being pressed into the hollow head part 1016 in the region of the transverse wall 1022 of the hollow head part 1016 as a result of a central post of the die arranged at a higher position.

The form-locked joint in the region of the rivet flange 1037 is then basically formed identically to the embodiment in accordance with Fig. 19; except that here, the annular fold 1052 is additionally supported on the inner side by the panel slug 1050.

As no swage 1035 is provided in the upper layer 1033 of the composite component 1030, the lower side of the flange part 1011 of the functional element contacts the upper side of the upper layer 1033. This is only
20 pressed in slightly, above all in the region of the nose features 1013 providing security against rotation, to produce just the required security against rotation. The composite component 1030 in both examples is under a certain compression between the flange part 1011 and the rivet flange 1037, which is of advantage for the quality and the stability of the
25 joint.

The functional elements described here can, for example, be made of all materials which reach the strength class 5.6. Such metal materials are usually carbon steels with a carbon content of 0.15 to 0.55%.

- 5 In all embodiments, all materials can also be named as examples for the material of the functional elements which reach strength values of Class 8 of the ISO standard as part of cold forming, for example a 35B2 alloy in accordance with DIN 1654. The fastening elements formed in this way are suitable, among other things, for all commercial steel materials for sheet
10 metal parts capable of being drawn as well as for aluminium or their alloys. Aluminium alloys, in particular such with a high strength, can also be used for the functional elements, e.g. AlMg₅.

The trials carried out up to now have shown that when the material 35B2
15 is used, the ratio of the radial wall thickness of the head part to the outer diameter of the head part is in the region of between 0.15 and 0.2. Higher values are to be desired as they increase the yield forces and the pull-out forces. However, it must be ensured that the pressing in forces do not lead to an impermissible deformation. With a diameter of 8 mm, a radial thick-
20 ness of 1.2 mm has proved to be favourable.

Claims

1. A functional element (10, 110, 210, 310, 510, 610, 710, 810), in
 5 particular a bolt element, consisting of a shaft part (14, 114, 214,
 314, 414, 514, 614, 714, 814) and a head part (16, 116, 216, 316,
 416, 516, 616, 716, 816) designed for a riveted joint to a panel ele-
 ment, in particular a sheet metal part (30, 130, 230, 330, 430, 630,
 730), wherein at least the head part is made hollow and has at least
 10 substantially the same outer diameter as the shaft part, character-
 ised in that the end (20, 120, 220, 320, 420, 520, 620, 720, 820) of
 the head part (16, 116, 216, 316, 416, 516, 616, 716, 816) remote
 from the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814) is
 made in a known manner with piercing and riveting features, and in
 15 that the length of the hollow head part (16, 116, 216, 316, 416, 516,
 616, 716, 816) is dimensioned at least such that its length amounts
 to the length of a rivet flange (37, 137, 237, 437, 637, 737) formed
 on the side of a sheet metal part (30, 130, 230, 430, 630, 730) re-
 mote from the shaft part (14, 114, 214, 314, 414, 514, 614, 714,
 20 814) plus the thickness of the sheet metal part and the double
 length of the radius of an annular fold (52, 152, 252, 452, 652, 752)
 formed on the side of the sheet metal part adjacent to the shaft part
 (14, 114, 214, 314, 414, 514, 614, 714).
 25 2. A functional element (10, 110, 210, 310, 410, 510, 610) in accor-
 dance with claim 1, characterised in that the end (20, 120, 220,
 320, 420, 520, 620) of the hollow head part (16, 116, 215, 316, 416,
 516, 616) merges into a rounded off punching and drawing edge (26,

628) from the circular cylindrical jacket surface and has a conical cutting face (26, 426 626) on the inside.

3. A functional element (10, 110, 210, 310, 410, 510, 610, 710, 810) in
5 accordance with one of the preceding claims, characterised in that the inner space (18, 118, 218, 318, 418, 518, 618, 718, 818) of the hollow head part (16, 116, 216, 316, 416, 516, 616, 716, 816) is at least substantially of a circular cylindrical shape.
- 10 4. A functional element (310, 410, 510, 610) in accordance with one of the preceding claims, characterised in that the shaft part (314, 414, 514, 614) is also made hollow.
5. A functional element (10, 110, 210, 310, 610, 710, 810) in accor-
15 dance with one of the preceding claims, characterised in that the shaft part (14, 114, 214, 314, 614, 714, 814) is provided with an external thread (12, 112, 212, 312, 612, 712, 812).
6. A functional element (410) in accordance with claim 4, characterised
20 in that the hollow shaft part (414) is provided with an internal thread (412).
7. A functional element (10, 110, 210, 310, 410, 510, 610, 710, 810) in
25 accordance with one of the preceding claims, characterised in that it is made as a cold formed part.
8. A functional element (310, 410, 510, 610) in accordance with one of the preceding claims, characterised in that it is made of raw mate-

rial, with any thread (312) present on the shaft part being manufactured in a thread rolling process or in a compression forming process.

- 5 9. A functional element (10, 110, 210, 310, 410, 510, 610, 710, 810), in particular a bolt element, characterised in that the head part (16, 116, 216, 316, 416, 516, 616, 716, 816) merges into the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814) without a flange part.
- 10 10. A functional element (1010), consisting of a shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814) and a head part (16, 116, 216, 316, 416, 516, 616, 716, 816) designed for a riveted joint to a panel element, in particular a sheet metal part (30, 130, 230, 330, 430, 630, 730), wherein at least the head part is made hollow and has at least
15 substantially the same outer diameter as the shaft part, characterised in that the length of the hollow head part (16, 116, 216, 316, 416, 516, 616, 716, 816) is dimensioned at least such that its length amounts to the length of a rivet flange (37, 137, 237, 437, 637, 737) formed on the side of a sheet metal part (30, 130, 230, 430, 630, 730) remote from the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814) plus the thickness of the sheet metal part and the double length of the radius of an annular fold (52, 152, 252, 452, 652, 752) formed on the side of the sheet metal part adjacent
20 to the shaft part (14, 114, 214, 314, 414, 514, 614, 714) and that a flange part (1011) is present between the hollow head part (1016) and the shaft part (1014), with the flange part (1011) optionally being able to have rotational security features on its side facing the
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head part and the flange part (1011) has a spacing from the hollow head part (1016).

11. A method for the manufacture of a joint between a functional ele-
5 ment (10, 110, 210, 310, 410, 510, 610, 710, 810) in accordance
with one of the preceding claims and a sheet metal part (30, 130,
230, 430, 630, 730), wherein the functional element consists of a
shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814) and a head
part (16, 116, 216, 316, 416, 516, 616, 716, 816) designed for a riv-
10 eted joint to the sheet metal part (30, 130, 230, 430, 630, 730) with
at least the head part being made hollow and having at least sub-
stantially the same outer diameter as the shaft part, and the end
(20, 120, 220, 320, 420, 520, 620, 720, 820) of the head part (16,
116, 216, 316, 416, 516, 616, 716, 816) remote from the shaft part
15 (14, 114, 214, 314, 414, 514, 614, 714, 814) is made in known
manner with piercing and riveting features and the sheet metal part
is pierced in a known manner by the end face (20, 120, 220, 320,
420, 520, 620, 720, 820) of the functional element while the sheet
metal part (30, 130, 230, 430, 630, 730) is simultaneously sup-
20 ported on a die (32) and is formed to form a rivet flange (37, 137,
237, 437, 637, 737) around the downwardly drawn rim of the aper-
ture and with the functional element (10, 110, 210, 310, 410, 510,
610, 710, 810) being pressed downwards after or just before com-
pletion of the rivet flange (37, 137, 237, 437, 637, 737) to make the
25 region of the hollow head part (16, 116, 216, 316, 416, 516, 616,
716, 816) adjacent to the shaft part (14, 114, 214, 314, 414, 514,
614, 714, 814) into an annular fold (52, 152, 252, 452, 652, 752)
which contacts the side of the sheet metal part (30, 130, 230, 430,

630, 730) remote from the rivet flange (37, 137, 237, 437, 637, 737) and adjacent to the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814).

- 5 12. A method in accordance with claim 11, characterised in that after the at least partial completion of the rivet flange (37, 137, 237, 437, 637), the sheet metal part (30, 130, 230, 430, 630) is pressed into an annular recess (40) of the die (32) by the annular fold (52, 152, 252, 452, 652) which is formed, with the diameter of the annular re-
10 cess (40) at the end of the die being greater than the diameter of the completed annular fold (52, 152, 252, 452, 652) so as to generate an annular recess in the sheet metal part with a depth which corre-
sponds at least substantially to the axial height of the annular fold (52, 152, 252, 452, 652), i.e. to at least substantially double the
15 height of the wall thickness of the hollow head part, and with a di-
ameter which corresponds at least substantially to the outer diame-
ter of the annular fold (52, 152, 252, 452, 652) plus double the
sheet metal thickness.
- 20 13. A method in accordance with claim 11 or claim 12, characterised in that pressure is exerted by a plunger (48) on the end (29, 129, 229, 329, 429, 529, 629, 729, 829) of the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814) remote from the head part to pierce the
sheet metal part (30, 130, 230, 430, 630, 730), while the sheet
25 metal part (30, 130, 230, 430, 630, 730) is supported at the rim of the die (32) outside the annular recess (40) so that the piercing of the sheet metal part is accompanied by the formation of a trumpet-
like recess in the sheet metal part and in that after the annular rivet

flange (37, 137, 237, 437, 637, 737) has been formed, the plunger (48) exerts an additional force on the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814) in the longitudinal direction of the functional element so as to form the region of the hollow head part (16, 116, 216, 316, 416, 516, 616, 716, 816) arranged above the sheet metal part into an annular fold (52, 152, 252, 452, 652, 752) and in that a plunger (42) arranged concentrically to the plunger is pressed downwards so as to compress the annular fold (52, 152, 252, 452, 652, 752) and to form an annular face (57, 157, 257, 457, 657, 757).

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14. A method in accordance with claim 13, characterised in that the annular face (57, 157, 257, 457, 657, 757) formed in this way is perpendicular to the longitudinal axis (24, 124, 224, 324, 424, 525, 624, 724) of the member (10, 110, 210, 310, 410, 510, 610, 710, 810) and is preferably flush with or slightly below or slightly above the plane of the sheet metal part in the region of the joint.

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15. A method in accordance with one of the claims 11 to 14, characterised in that the panel slug (50, 150, 250, 450, 650, 750) formed by the piercing section of the head part is forced inside the rivet flange (37, 137, 237, 437, 637, 737) by a plunger projection (34) of the die (32) in order to further increase the strength of the riveted joint.

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16. A component assembly comprising a sheet metal part (30, 130, 230, 430, 630, 730) and a functional element (10, 110, 210, 310, 410, 510, 610, 710, 810) in accordance with one of the preceding claims 1 to 10, and manufactured in accordance with one of the methods of

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claims 11 to 15, characterised in that a rivet flange (37, 137, 237, 437, 637, 737) is located on the side of the sheet metal part remote from the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814), while an annular fold (52, 152, 252, 452, 652, 752) is located on the side of the sheet metal part (30, 130, 230, 430, 630, 730) adjacent to the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814), and in that the sheet metal part (30, 130, 230, 430, 630, 730) is clamped between the annular fold (52, 152, 252, 452, 652, 752) and the rivet flange (37, 137, 237, 437, 637, 737) in the region of the joint to the functional element (10, 110, 210, 310, 410, 510, 610, 710, 810), in that the annular fold (52, 152, 252, 452, 652, 752) is arranged in an annular recess of the sheet metal part, with an annular face (57, 152, 257, 457, 657, 757) of the annular fold (52, 152, 252, 452, 652, 752) facing the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814) being arranged either slightly below or slightly above the side of the sheet metal part facing the shaft part (14, 114, 214, 314, 414, 514, 614, 714, 814) in the region of the riveted joint, or being at the same height as the side of the sheet metal part (30, 130, 230, 430, 630, 730).

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17. A component assembly in accordance with claim 16, characterised in that a panel slug (50, 150, 250, 450, 650, 750) is located inside the annular rivet flange (37, 137, 237, 437, 637, 737) and preferably presses against this.

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18. A component assembly in accordance with one of the claims 16 or 17, characterised in that the sheet metal part is a composite component (1030).

19. A method in accordance with one of the claims 11-15, with a die (732) being used, having an annular recess (740) provided on one end face (733) and arranged around a centrally disposed plunger projection (734), with the plunger projection being designed to cooperate with a tubular head part (716) of a functional element (710) in order to remove a panel slug (750) from a sheet metal part (730) and with the annular recess (740) being designed to move the end region of the tubular head part (716) around the rim region (778) of the sheet metal part which is pressed into the recess formed after the removal of the panel slug and to form it there into a rivet flange (737), characterised in that the plunger projection (734) projects beyond the end face (733) of the die (732) lying outside the annular recess.
20. A method in accordance with one of the claims 11 to 15, with a die (732) being used, having an annular recess (740) provided on one end (733) and arranged around a centrally disposed plunger projection (734), with the plunger projection being designed to cooperate with a tubular head part (716) of a functional element (710) in order to remove a panel slug (750) from a sheet metal part (730) and with the annular recess (740) being designed to move the end region of the tubular head part (716) around the rim region (778) of the sheet metal part which is pressed into the recess formed after the removal of the panel slug and to form it there into a rivet flange (737), characterised in that grooves (739) are worked into the end face (733) of the die (732) around the recess (740) at preferably equal angular intervals and are preferably arranged radially and inclined to the longitudinal axis (724) of the die, whereby rotational security features

can be generated in the sheet metal part and in the adjacent material of the head part.

21. A method in accordance with one of the claims 11 to 15 for use with
5 a functional element (810) having a shaft part (814) with form features and a head part (816), in particular a functional element in accordance with one of the claims 1 to 10, wherein a plunger arrangement is used, characterised by
 - an outer plunger (842);
 - 10 - an inner plunger (848) which is arranged movably with respect to the outer plunger within a plunger passage (886) of the outer plunger (842) between a receiving position for the functional element (810) and an insertion position for the functional element (810), with the functional element being able to be inserted into
15 the plunger passage (886) when in the receiving position, preferably from the side and with the head part (816) of the functional element projecting out of the plunger arrangement (843) when in the insertion position; and
 - by at least two segments (904) supported by the outer plunger
20 which preferably have form features on one inner side (908) which can engage into the form features of the shaft part (814) of the functional element and which are movable between an open position (Fig. 18B) remote from the shaft part (814) of the functional element and a closed position (Fig. 18C) in engagement
25 with the form features of the shaft part (814).
22. A method in accordance with claim 21, characterised in that the outer plunger has an upper part (894) and a lower part (892) fas-

tened to the upper part, with a conical recess (898) arranged concentrically to the longitudinal axis (824') of the die being provided in the lower part (892) and the segments (904) having corresponding conical surfaces (920), in that the segments are biased in each case upwardly in the direction of the upper part (894) against said upper part (894) by spring-biased tappets (928) preferably set obliquely to the longitudinal axis (824') of the plunger arrangement, with their form features being able to engage in this position in those (812) of the functional element (810) pushed forward under the pressure of the inner plunger (848) , and in that the tappets (928) can be urged rearwardly by means of a drawing force exerted on the functional element and drawing it out of the plunger passage and the segments and move against the conical recess (898) of the lower part and thus into the open position to release the functional element.

23. A method in accordance with claim 21, characterised in that the upper part (894) of the outer plunger (842) has a conical recess (900), which is also arranged concentrically to the longitudinal axis (824') of the die, to centre the segments (904) and in that the segments (904) have further conical surfaces (914) which come into engagement with said conical recess (900) in the closed position.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES
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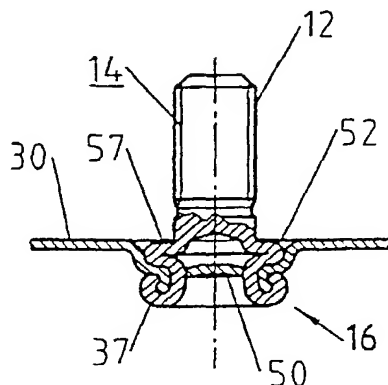
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(BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE,
SN, TD, TG).

[Fortsetzung auf der nächsten Seite]

(54) Title: FUNCTIONAL ELEMENT, METHOD FOR FIXING IT IN A SHEET METAL PART, ASSEMBLING ELEMENT
AND SWAGING ASSEMBLY

(54) Bezeichnung: FUNKTIONSELEMENT, VERFAHREN ZUM EINBRINGEN DES FUNKTIONSELEMENTES IN EIN
BLECHTEIL, ZUSAMMENBAUTEIL UND STEMPELANORDNUNG



(57) Abstract: The invention concerns a functional element, in particular a bolt, consisting of a shank portion (14) and a head portion (16) designed to be assembled riveted with a plate element, in particular a sheet metal part. The invention is characterised in that the head portion (16) is hollow and has practically the same external diameter as the shank portion. When mounted, the hollow head portion (16) of the functional element (10) forms a riveting edge (37) on one side of the sheet metal part and an annular groove (52) on the other side of the sheet metal part, the annular groove (52) acting as a flange. The invention further concerns a method for fixing the functional element in a sheet metal part and the resulting assembling element (16), as well as a matrix and a swaging assembly.

(57) Zusammenfassung: Die Erfindung betrifft ein Funktionselement, insbesondere Bolzenelement, bestehend aus einem Schaftteil (14) und einem für eine Nietverbindung mit einem Tafелеlement, insbesondere einem Blechteil ausgelegten Kopfteil (16), wobei mindestens das Kopfteil (16) hohl ausgebildet ist und zumindest

im Wesentlichen den gleichen Aussendurchmesser wie das Schaftteil aufweist. Im eingebauten Zustand bildet das hohle Kopfteil (16) des Funktionselements (10) ein Nietbördel (37) auf der einen Seite des Blechteils und einen Ringfalz (52) auf der anderen Seite des Blechteils, wobei der Ringfalz (52) dann als Flanschteil dient. Beschrieben und beansprucht wird auch ein Verfahren zum Einbringen des Funktionselements in ein Blechteil und das so entstandene Zusammenbauteil (16) sowie eine Matrize und eine Stempelanordnung.

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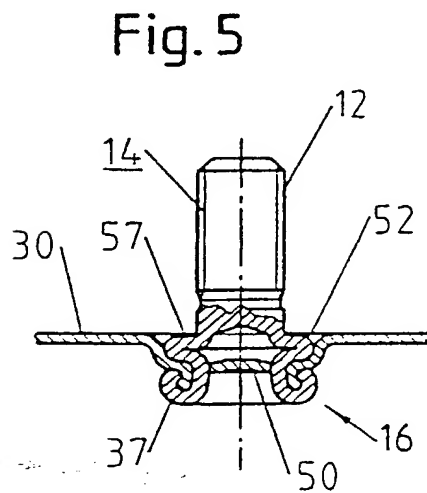
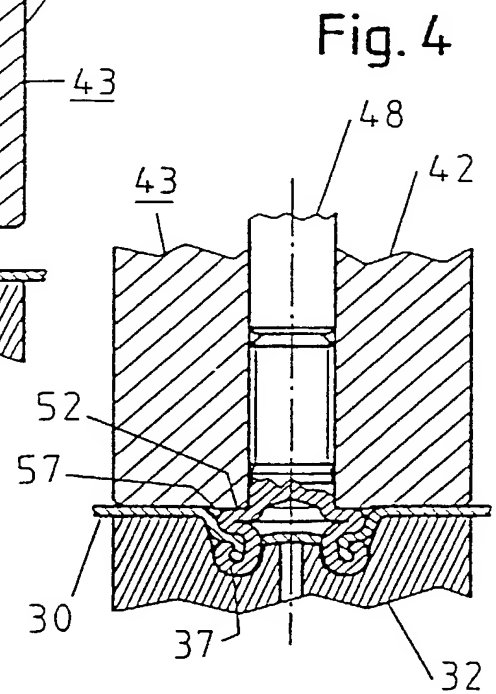
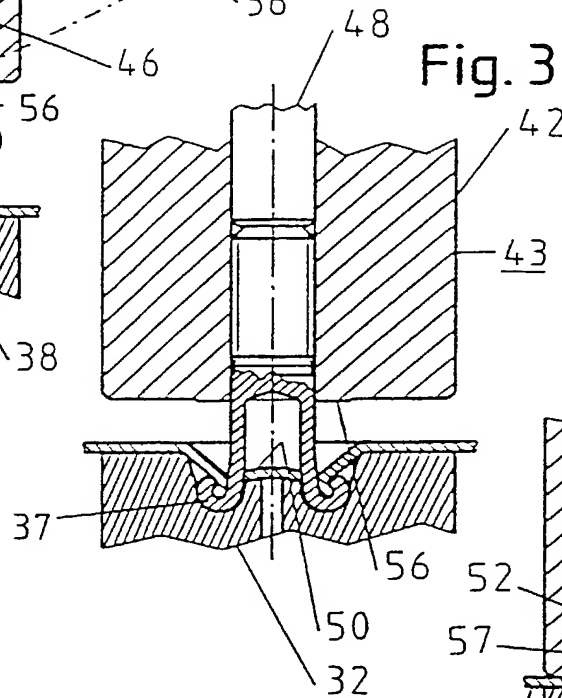
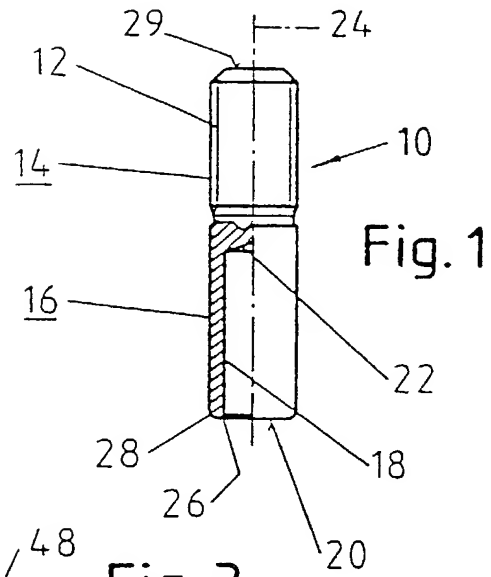
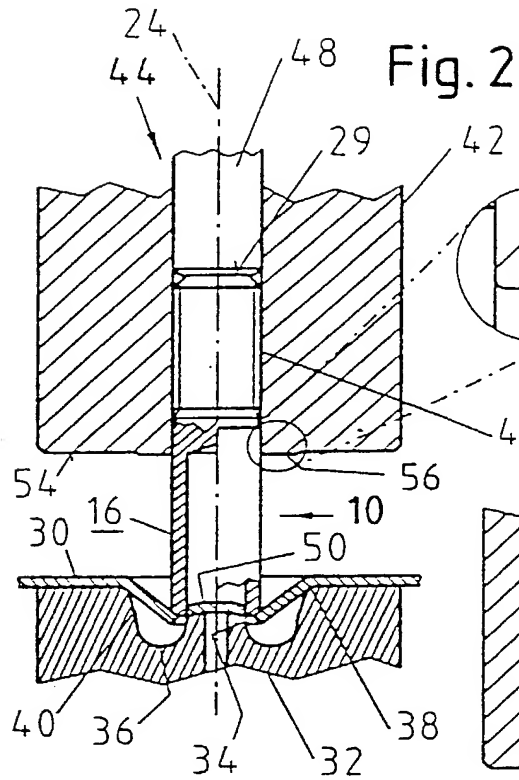


Fig. 6

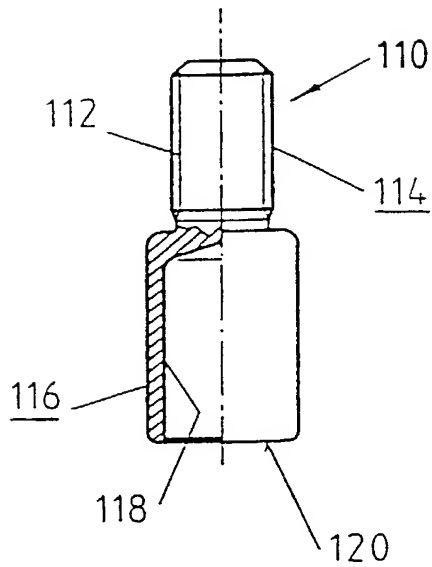


Fig. 7

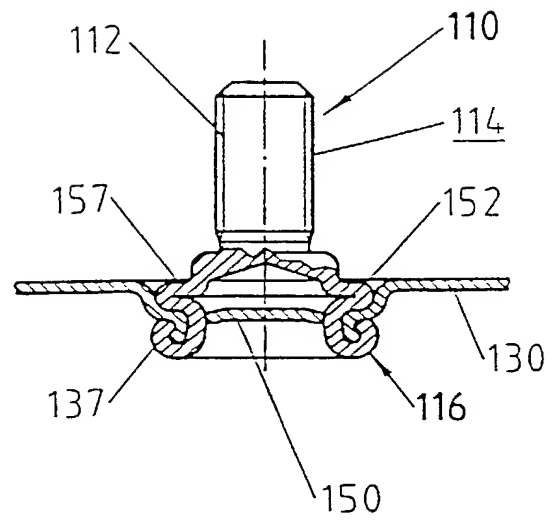


Fig. 8

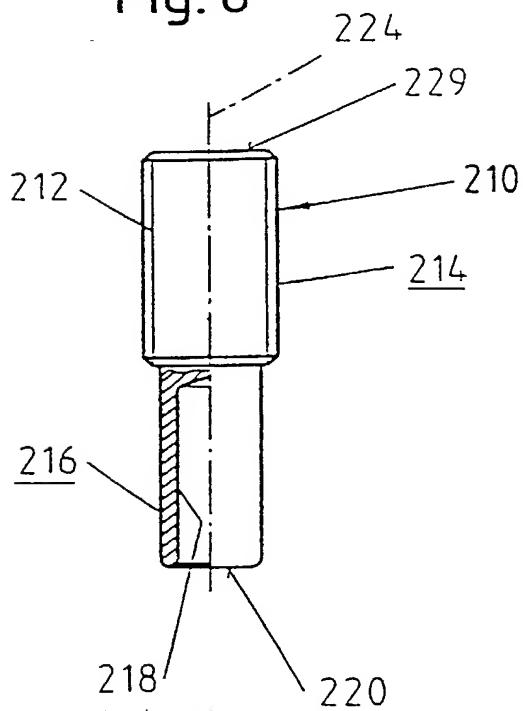


Fig. 9

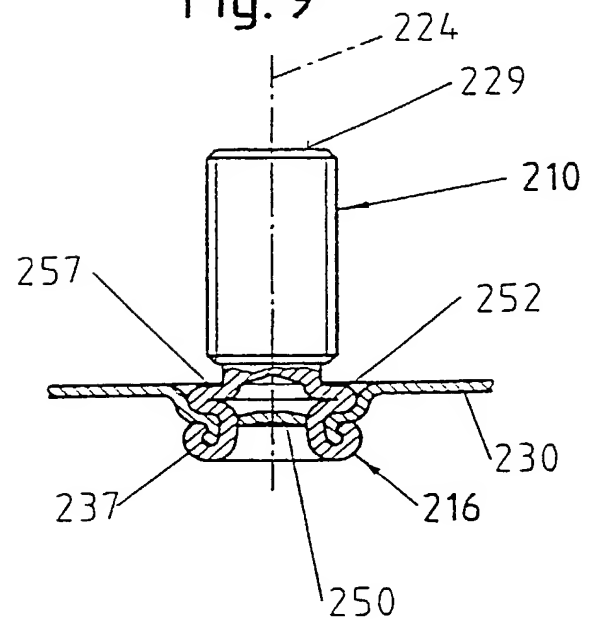


Fig. 10

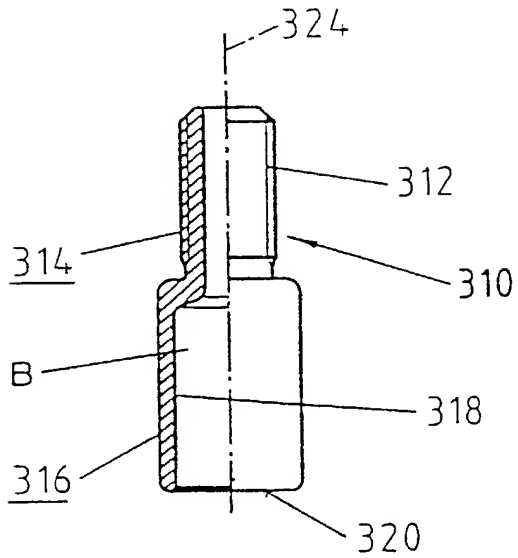


Fig. 11

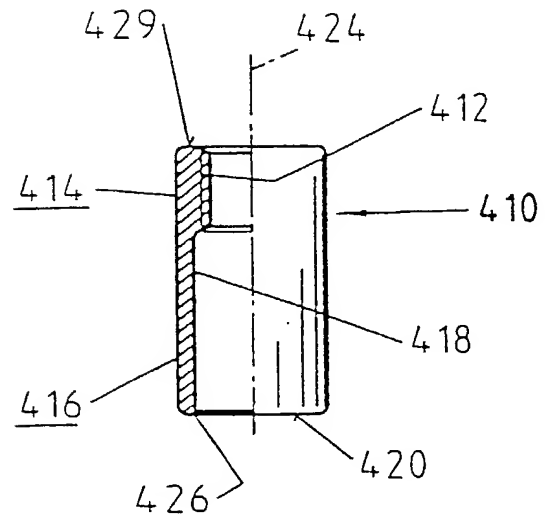


Fig. 12

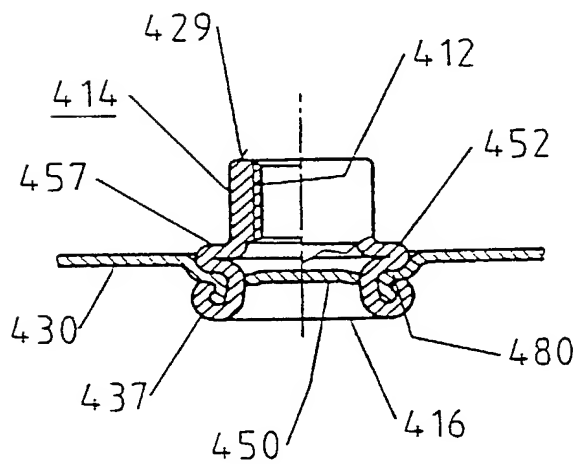
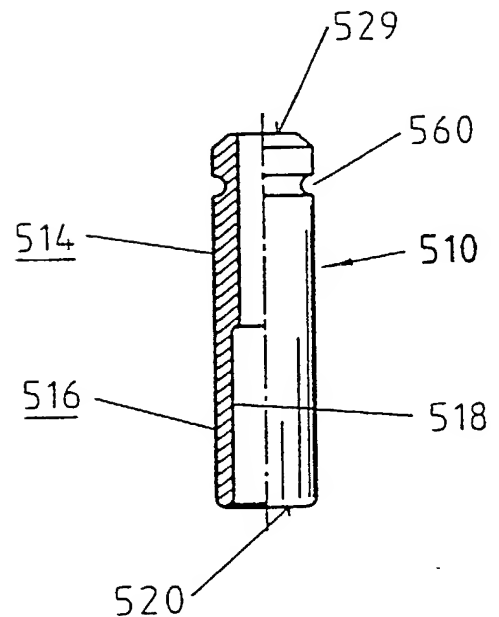


Fig. 13



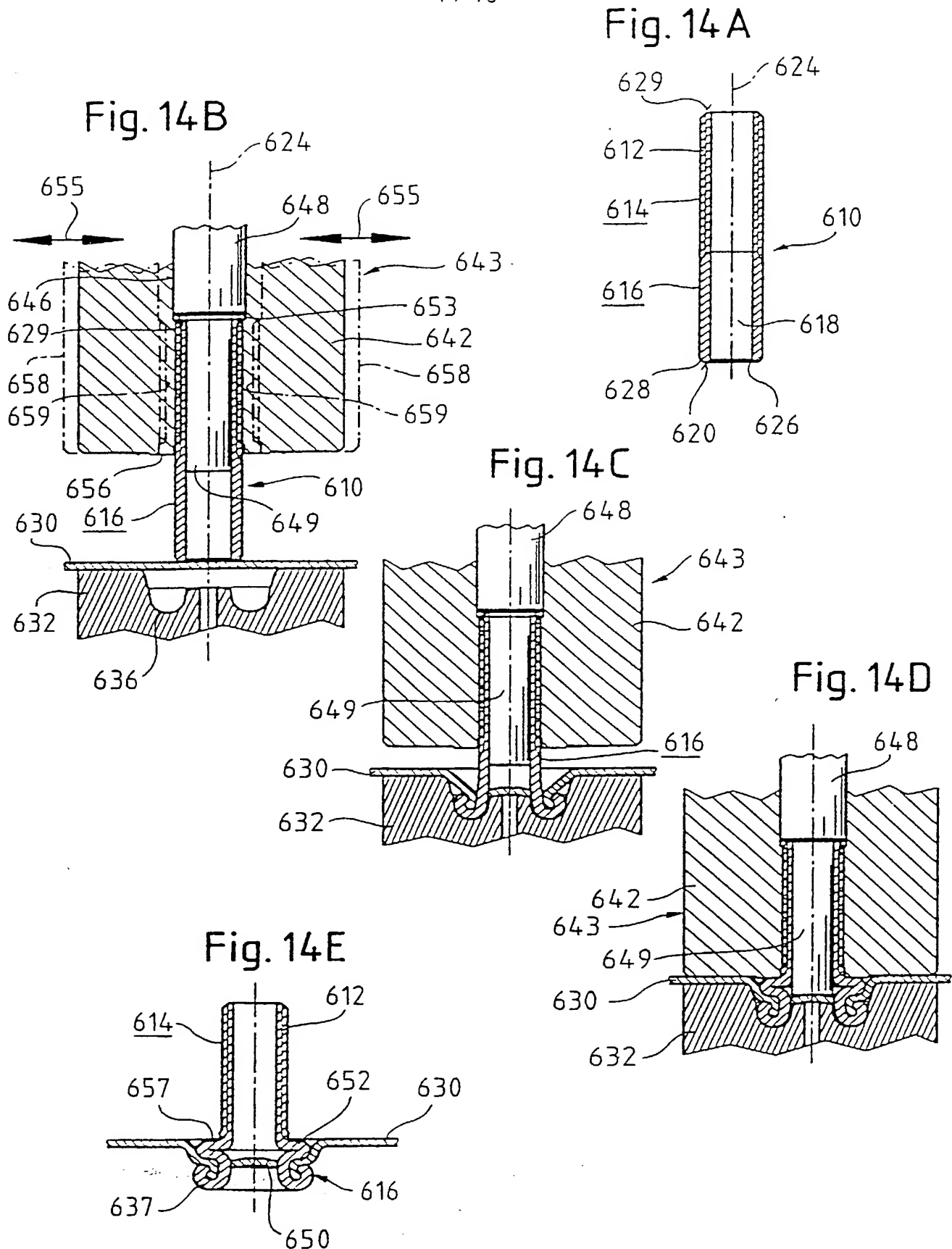


Fig. 15

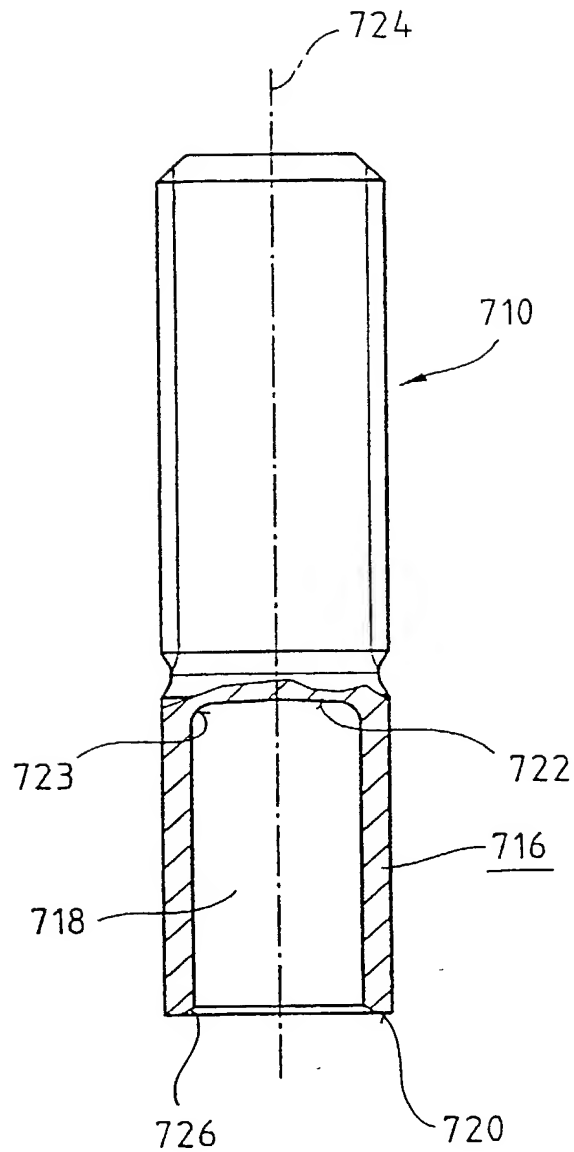


Fig. 16A

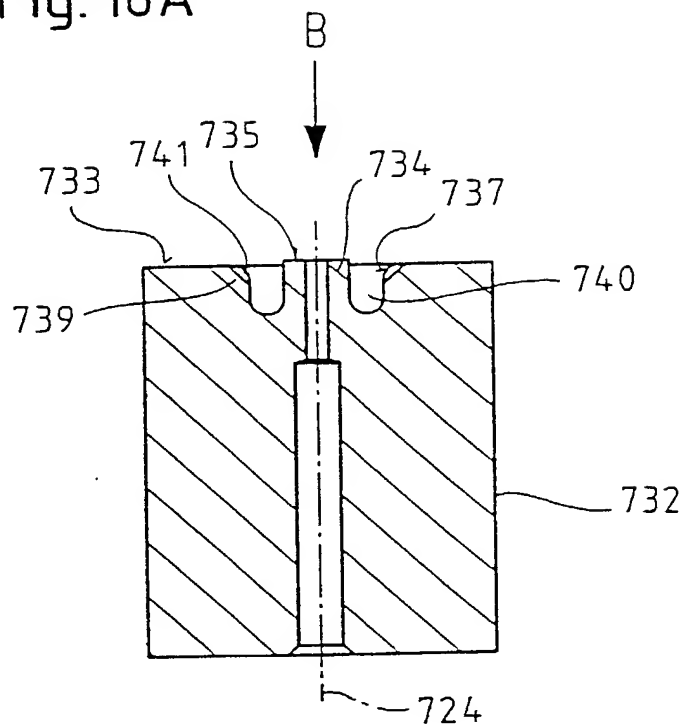
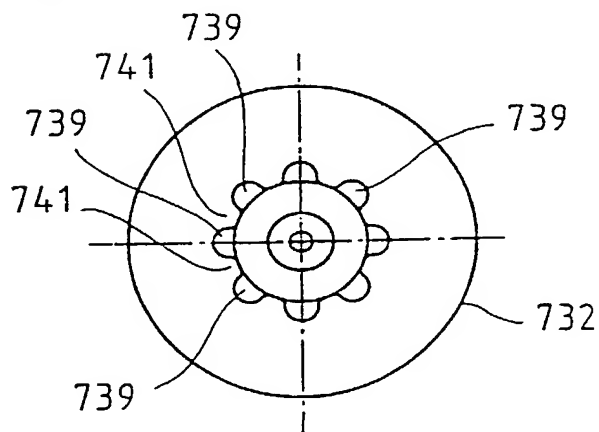


Fig. 16B



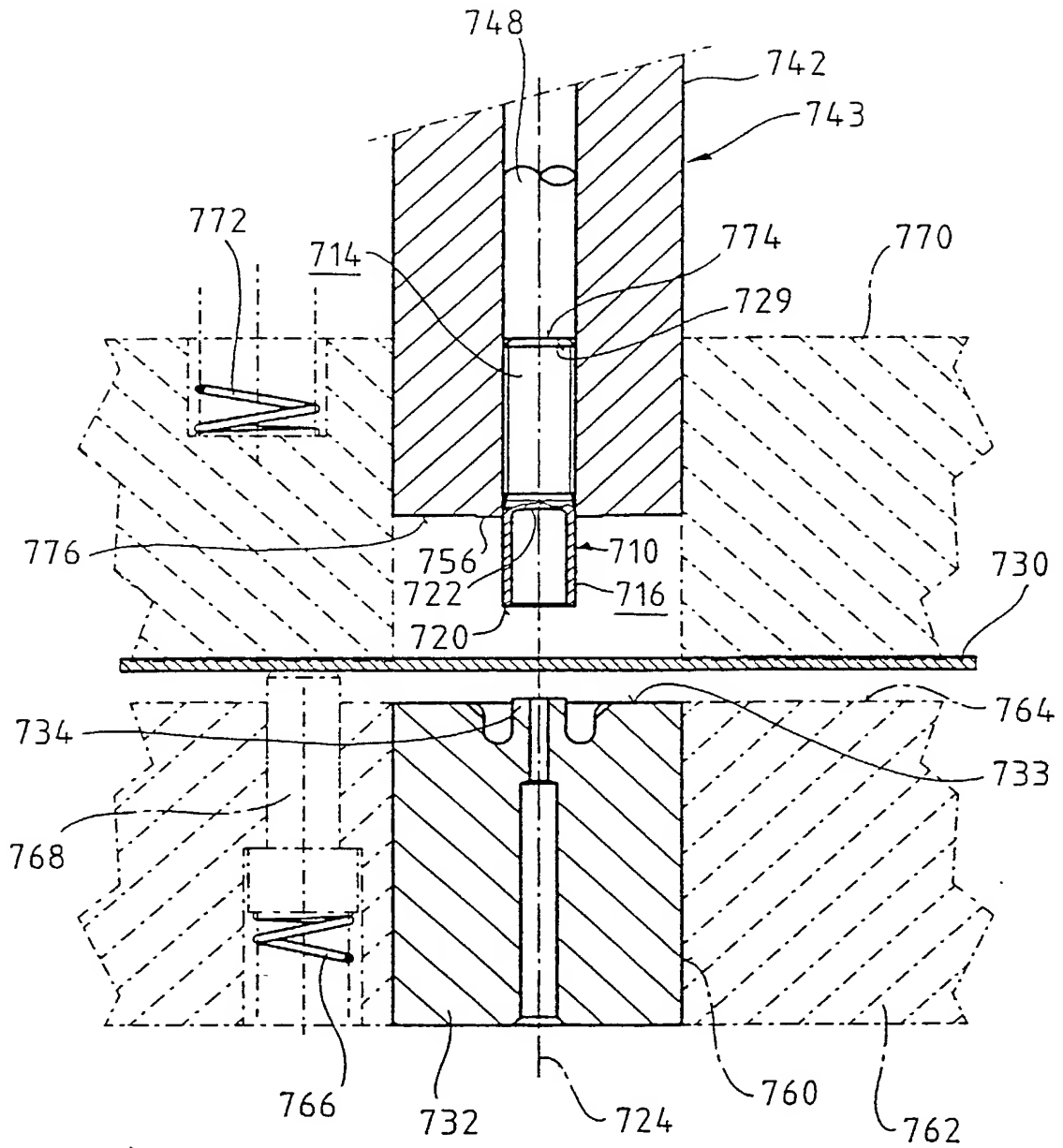


FIG. 17A

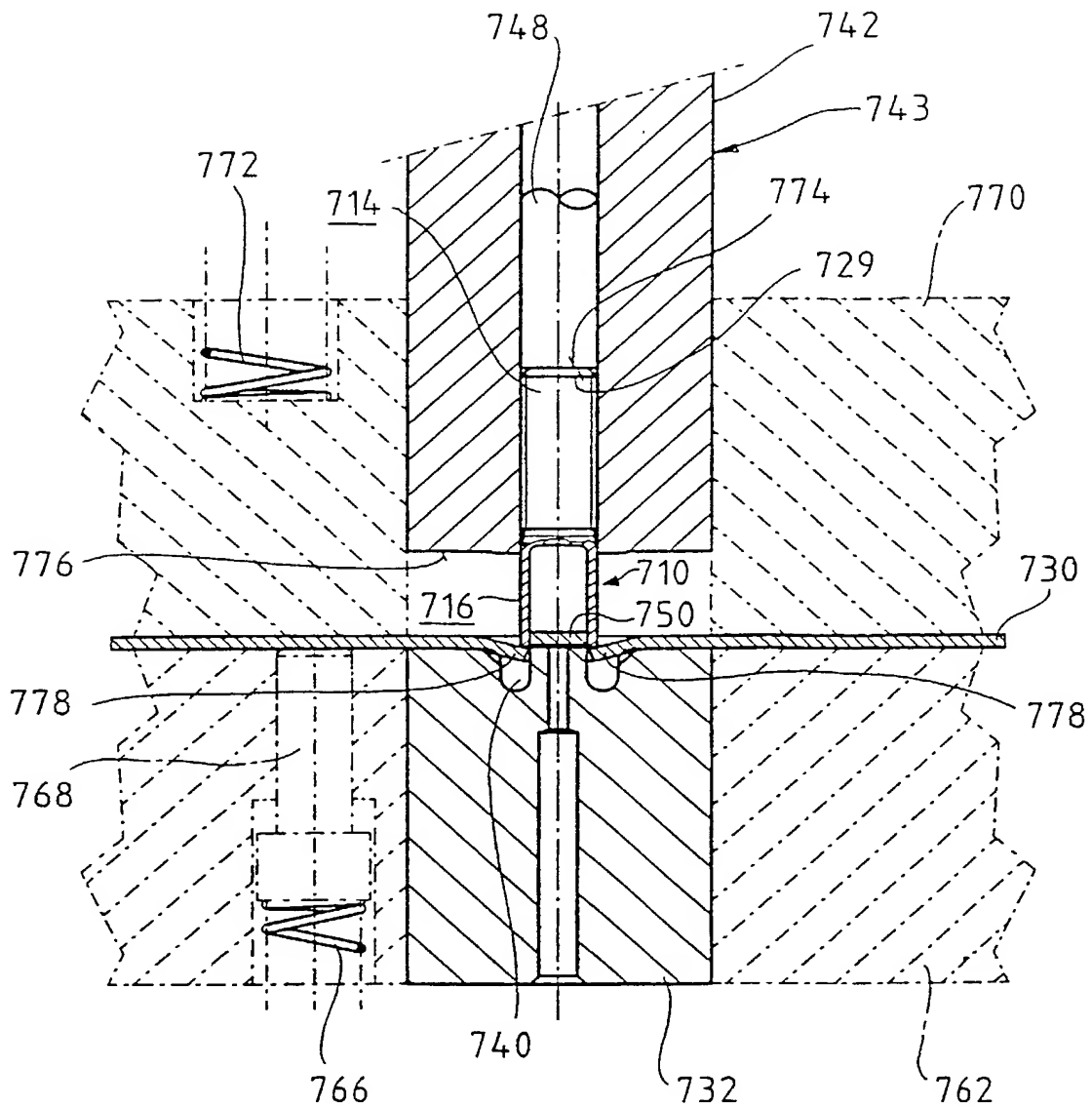


FIG. 17B

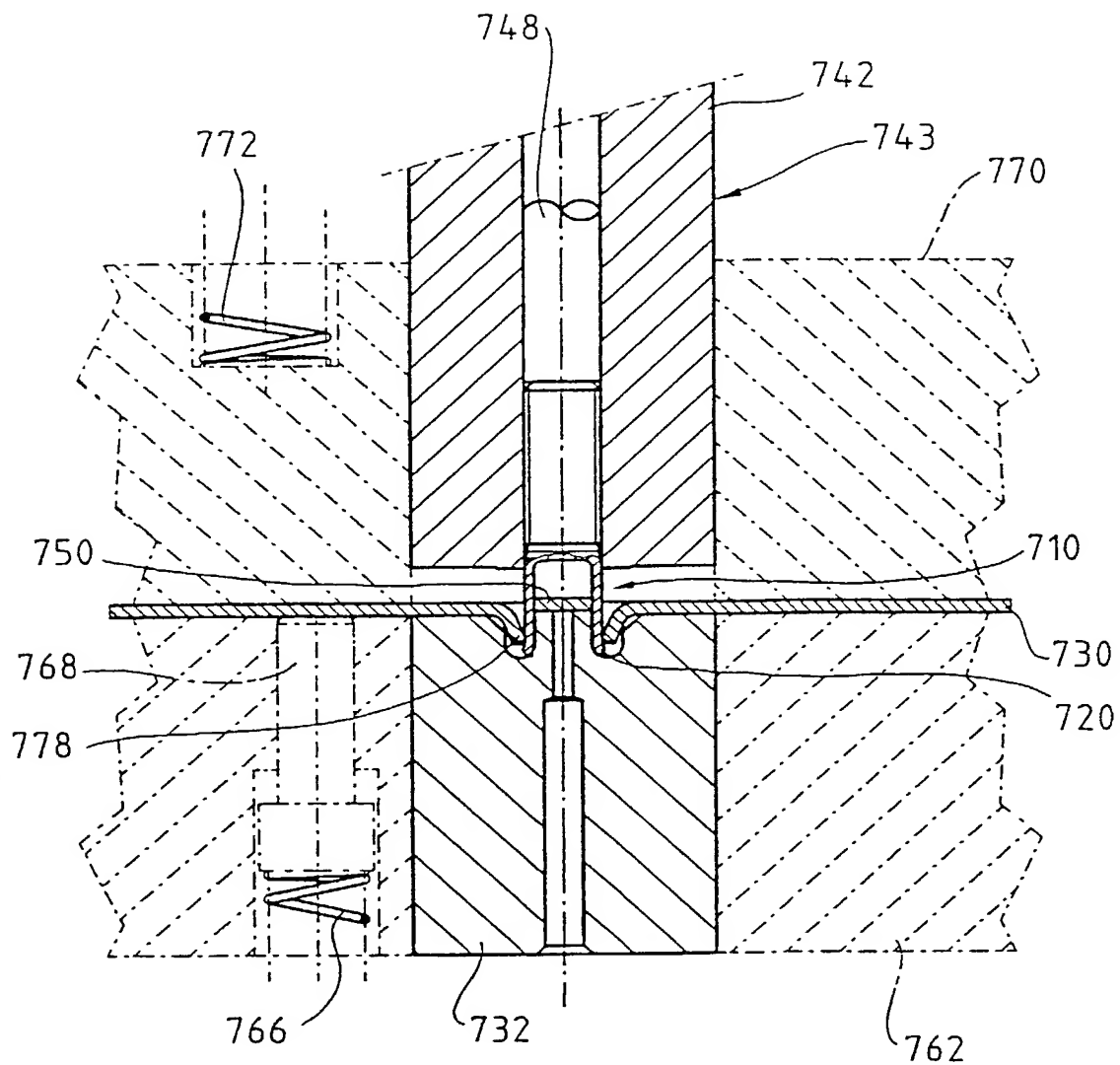


FIG. 17C

Fig. 17D

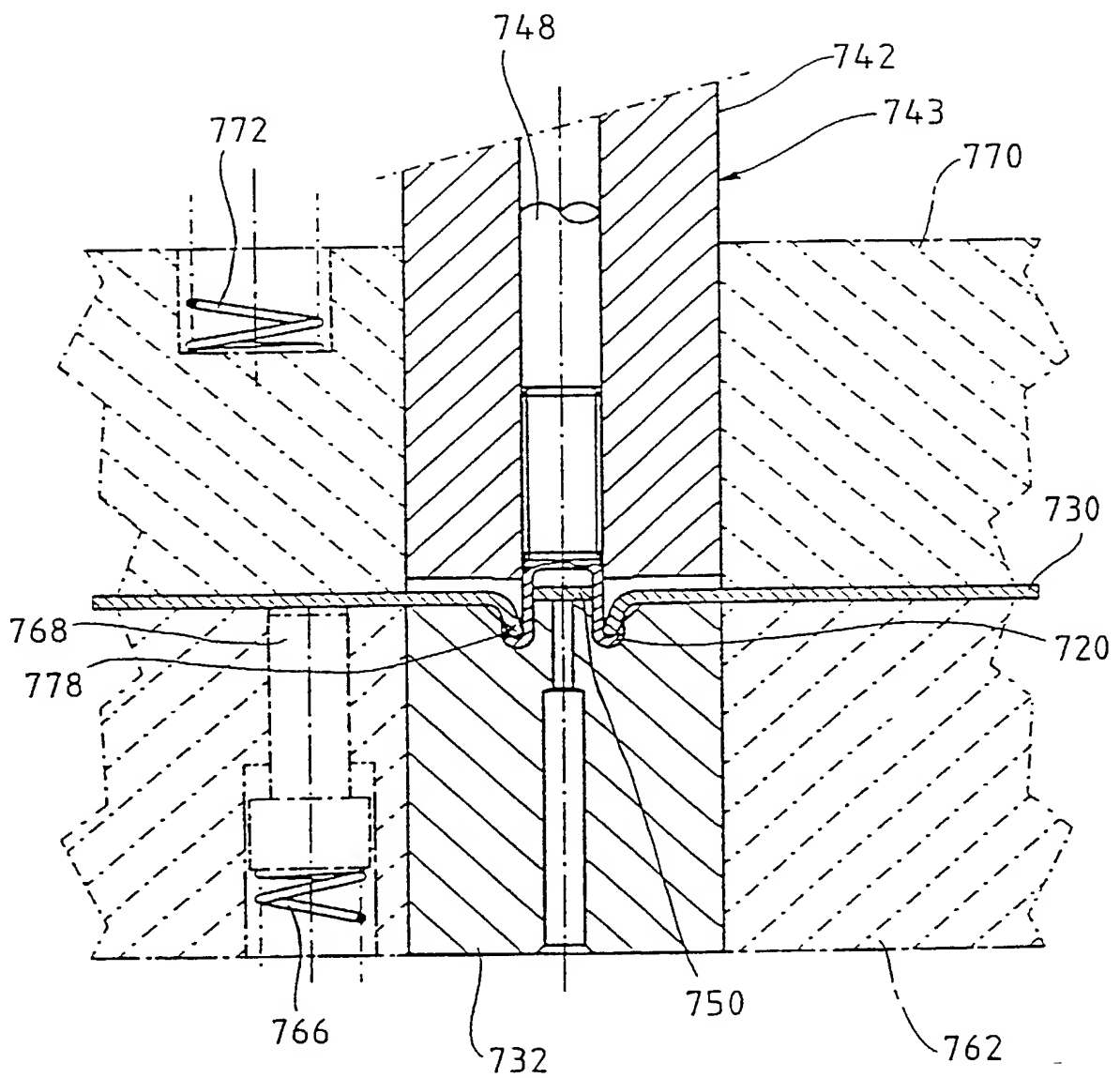


Fig. 17E

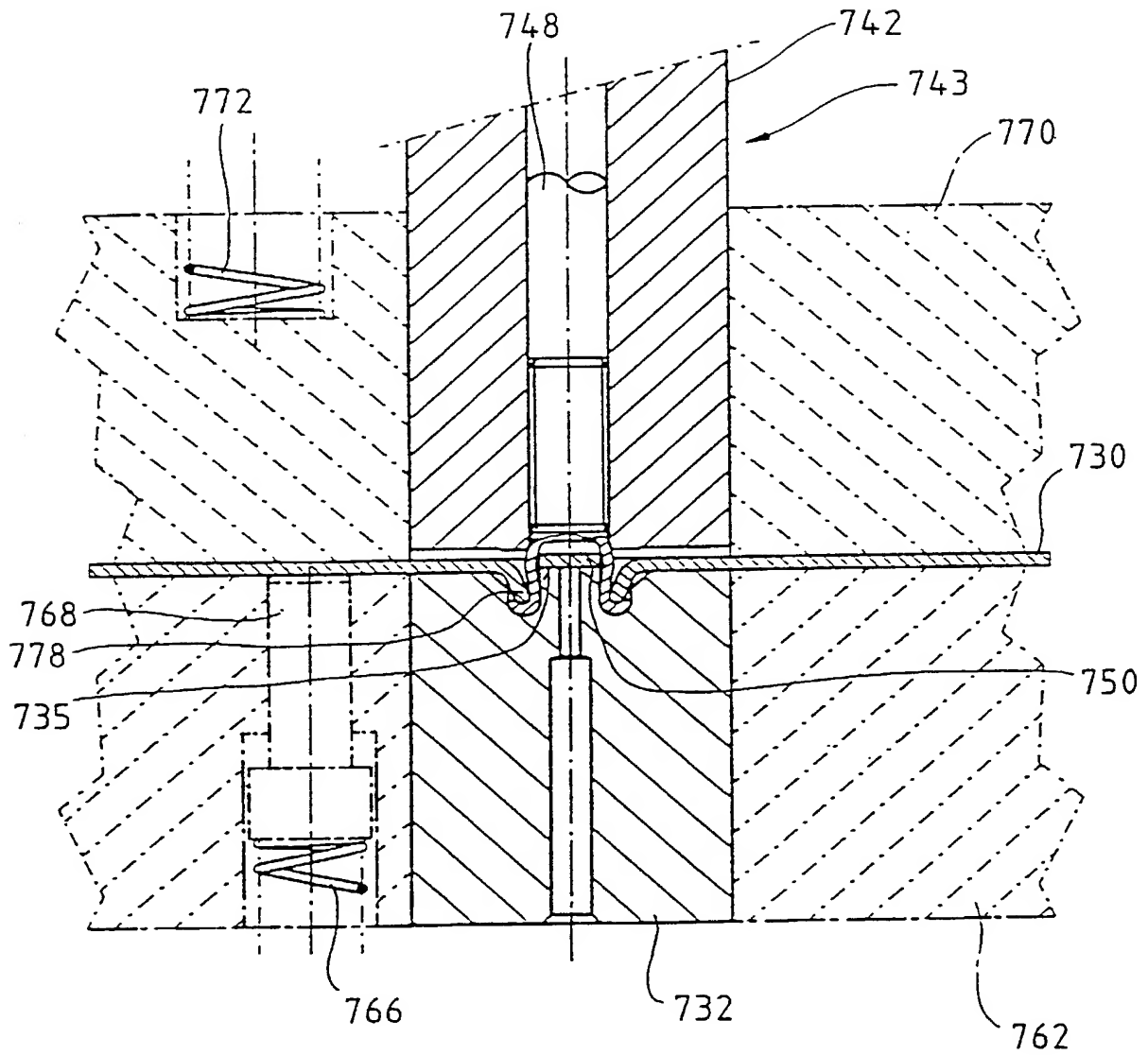


Fig. 17F

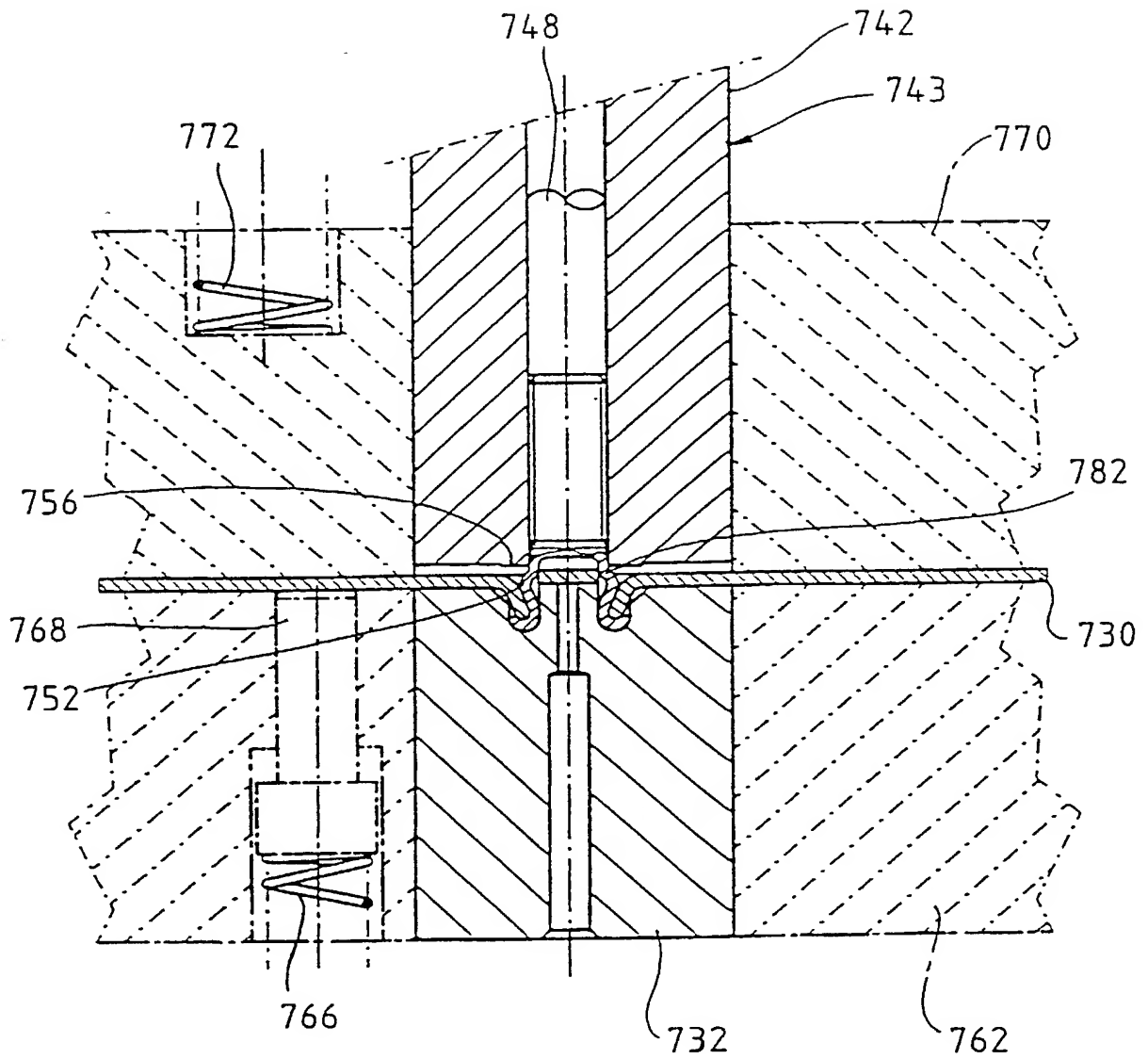


Fig. 17G

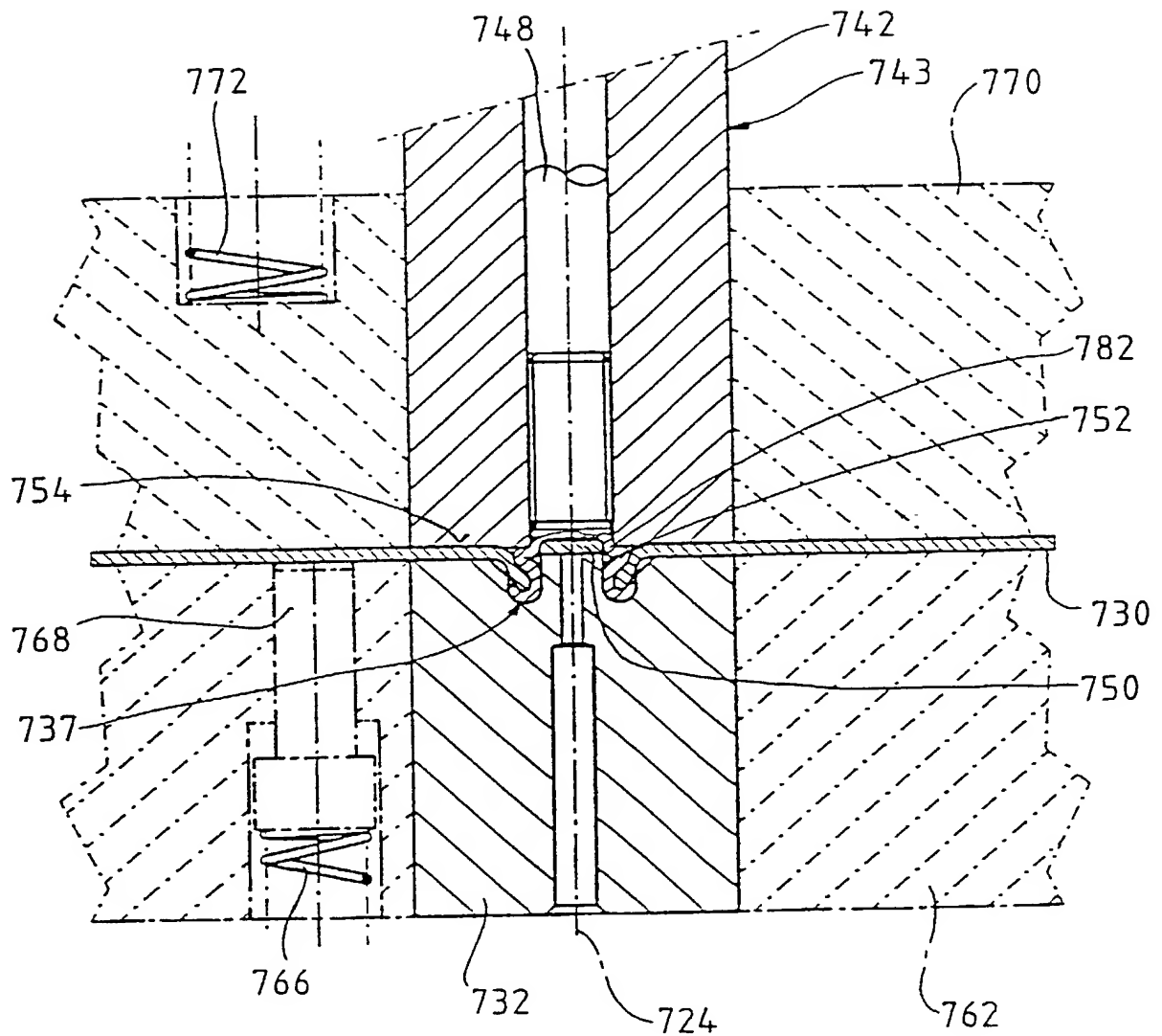


Fig. 17H

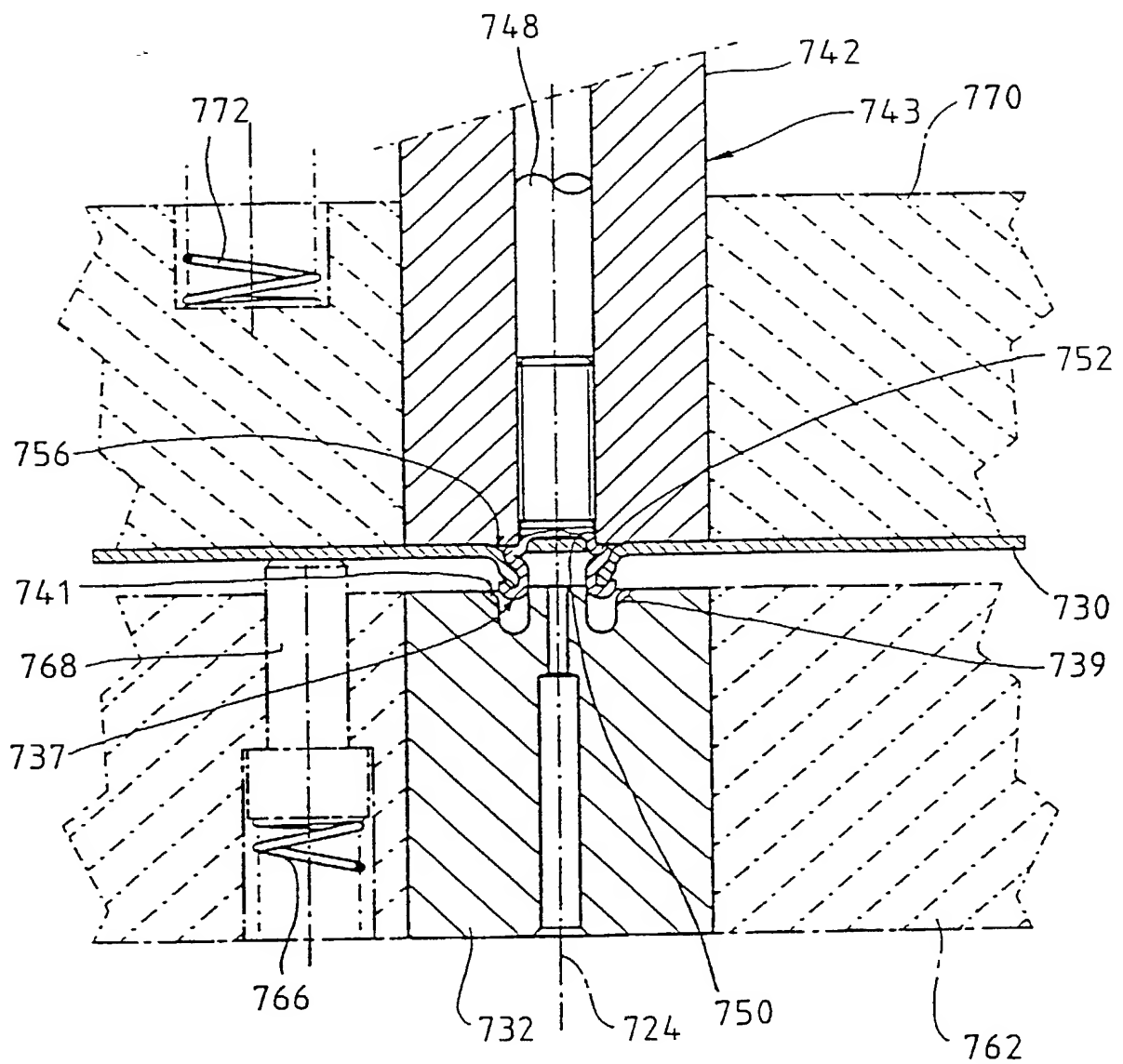


Fig. 17I

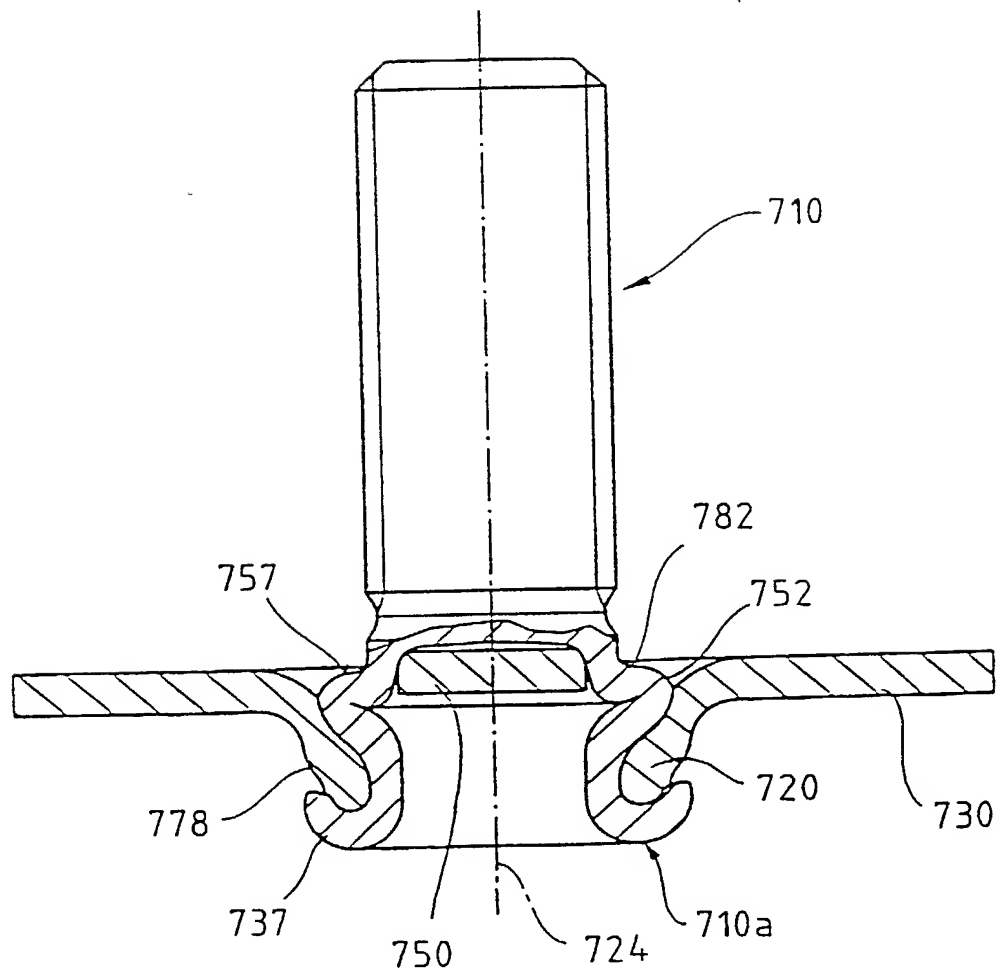


Fig. 18A

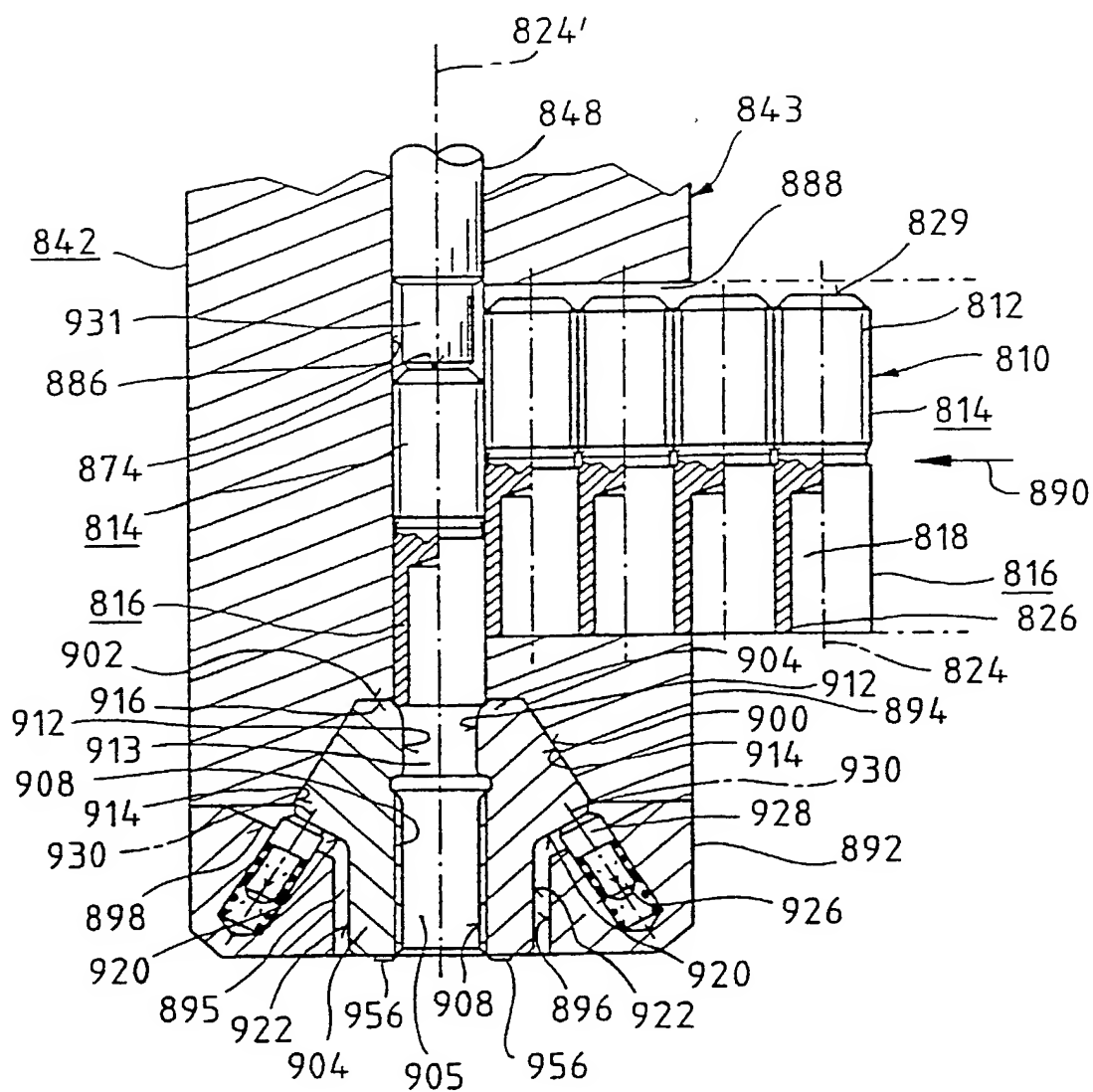


Fig. 18B

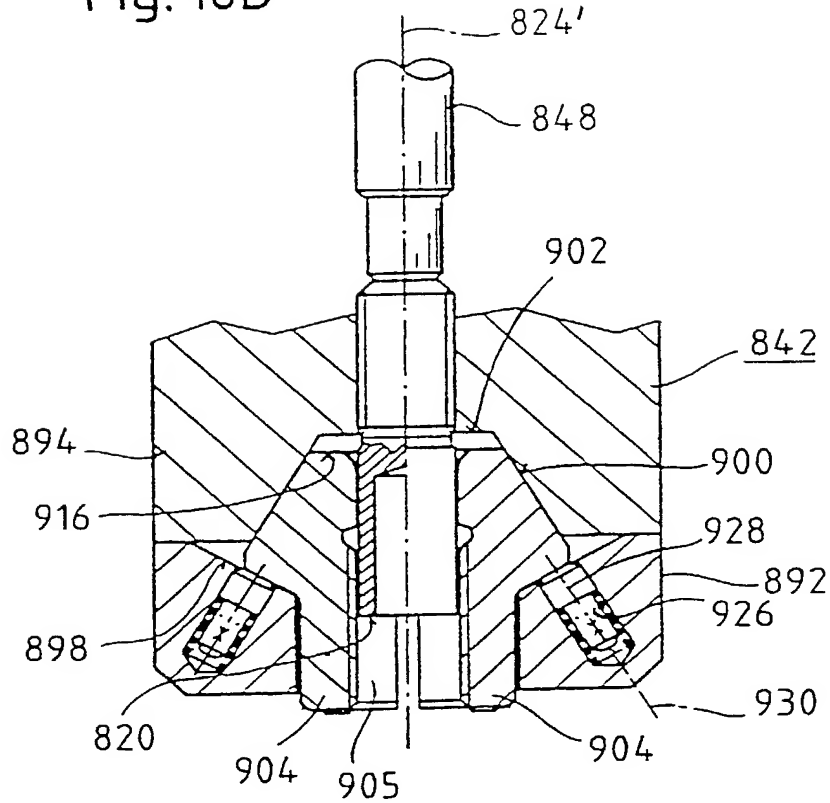


Fig. 18C

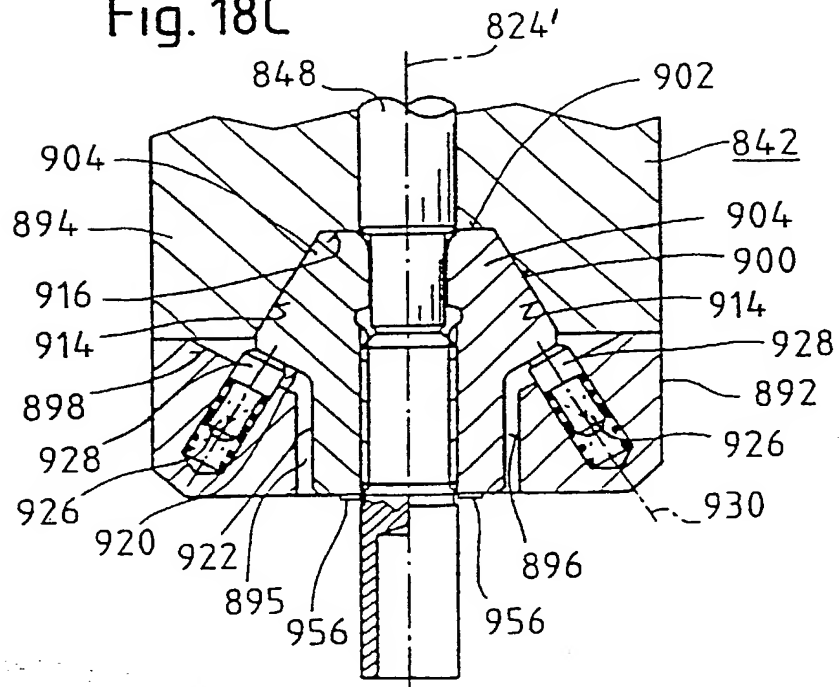


Fig. 19

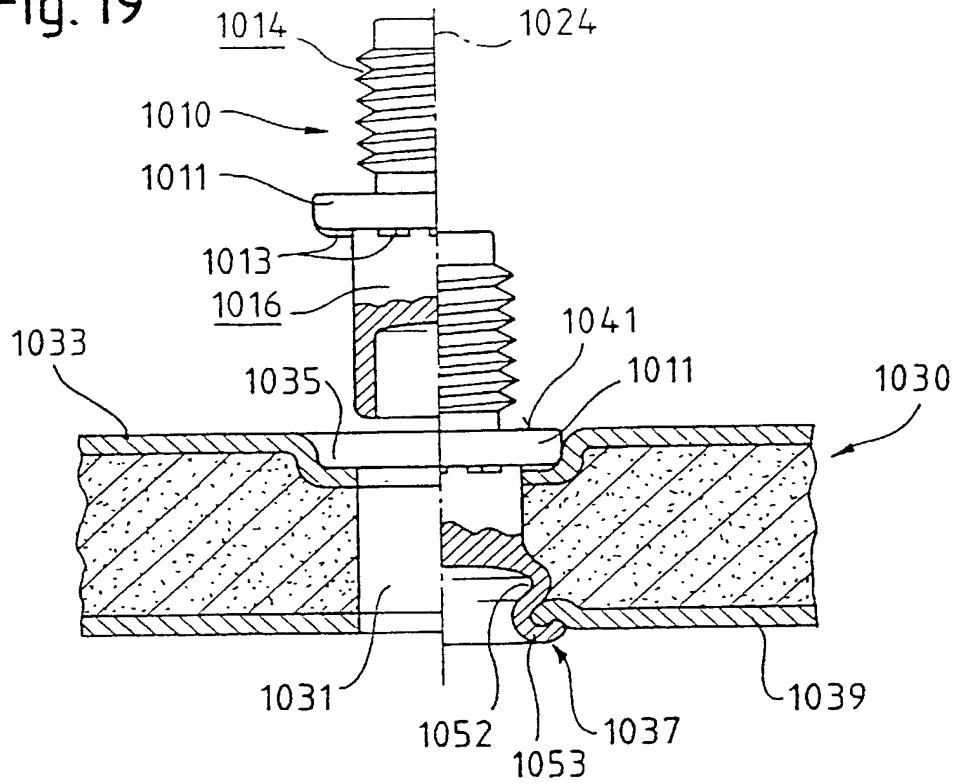
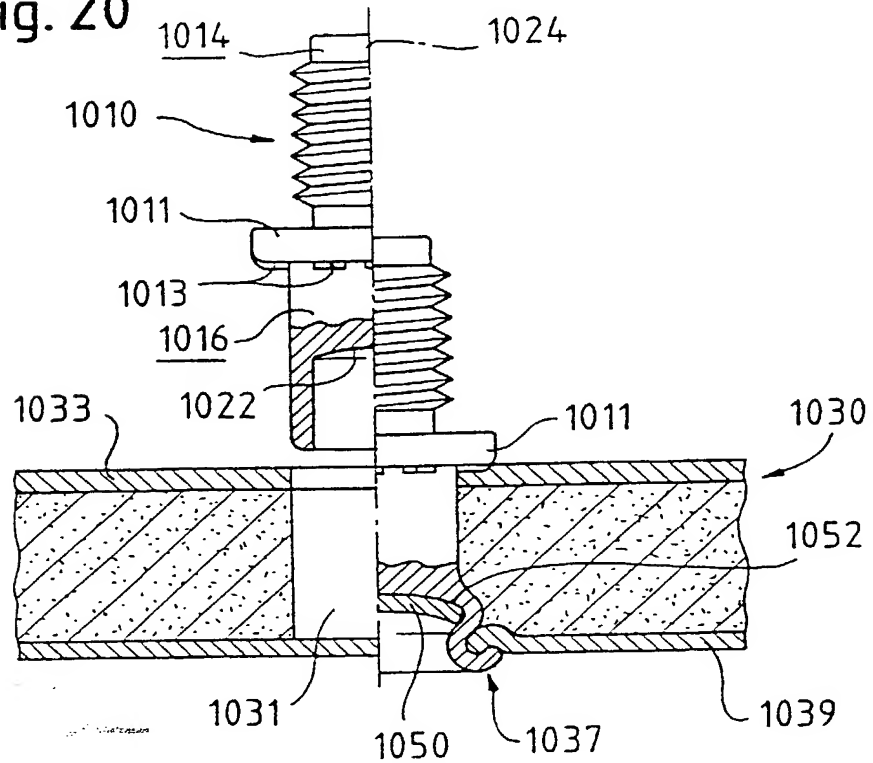


Fig. 20



I hereby claim that no application for patent or inventor's certificate on this invention has been filed in any foreign country or in the United States of America prior to this application by me or my legal representatives or assigns except as follows:

PRIORITY CLAIM

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of the foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

 no such applications have been filed.

 X such applications have been filed as follows:

| COUNTRY | APPLICATION NUMBER | DATE OF FILING (month, day, year) | PRIORITY CLAIMED UNDER 37 USC 119 |
|---------|-----------------------|--------------------------------------|-----------------------------------------|
| Germany | PCT/EP00/06465 | July 7, 2000 | |

I hereby claim priority to and all the benefits under Title 35, United States Code, §119(e) of any United States provisional application(s).

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 such applications have been filed as follows:

| APPLICATION NUMBER | DATE OF FILING (month, day, year) |
|-----------------------|--------------------------------------|
|-----------------------|--------------------------------------|

I hereby claim priority to and all the benefits under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of the above identified application is not disclosed in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the filing date of this application.

 X no such applications have been filed.

 such applications have been filed as follows:

| APPLICATION NUMBER | DATE OF FILING (month, day, year) | STATUS (patented, pending, abandoned) |
|-----------------------|--------------------------------------|------------------------------------------|
|-----------------------|--------------------------------------|------------------------------------------|

POWER OF ATTORNEY

As a named inventor, I hereby appoint the following attorneys and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith with full power of substitution and revocation. (all names listed with corresponding registration numbers)

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|---------------------|---------------|----------------------|---------------|
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| William H. Honaker | <u>31,623</u> | Jeffrey A. Sadowski | <u>29,005</u> |
| Raymond E. Scott | <u>22,981</u> | Randall L. Shoemaker | <u>43,118</u> |
| Gregory D. DeGrazia | <u>48,944</u> | Steven C. Wichmann | <u>37,758</u> |
| Samuel J. Haidle | <u>42,619</u> | James R. Yee | <u>34,460</u> |
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DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

23.05.02
 Date

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